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Sarah Oeste-Reiß

Leveraging the Potentials of Peer Learning

Conceptual Foundations and Reference Processes for Peer Learning

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Geleitwort

Die digitale Transformation verändert wie wir leben und arbeiten. Dies führt zu teilweise dramatischen Veränderungen in vielen Berufen und den dafür notwendigen Fertigkeiten, Fähigkeiten und Kenntnissen. Die Qualifikationsanforderungen an Wissensarbeiter steigen und ändern sich stetig. Lebenslanges Lernen und die Unterstützung beim Wissenserwerb und -transfer sowie beim Erwerb berufsrelevanter Kompetenzen (z.B. kritisches Denken, Problemlösen, Kommunikations- und Kooperationsfähigkeit) sind von wachsender Bedeutung. Damit einhergehend ist das Interesse in Wissenschaft und Praxis für Bildungsangebote und Lösungen zur Unterstützung des Wissenserwerbs und -transfers insbesondere arbeitsplatznah und berufsbegleitend seit vielen Jahren ungebrochen steigend. Neben den veränderten Qualifikationsanforderungen und den damit verbundenen Herausforderungen ermöglicht die Digitalisierung aber auch das Entstehen neuer Formen des Lernens und von Zusammenarbeit, die räumliche und zeitliche Grenzen überwinden können. Dies liefert vielversprechende Potenziale insb. für den Wissenserwerb und -transfer sowie den Erwerb berufsrelevanter Kompetenzen. In diesem Spannungsfeld können pädagogische Ansätze identifiziert werden, die das Potenzial haben, den Erwerb berufsrelevanter Kompetenzen zu fördern, jedoch die Potenziale neuer digitaler Lehr-Lernszenarien nicht hinreichend ausschöpfen. Das sog. „Peer Lernen" hat das Potenzial, Lernende durch den gegenseitigen Austausch mit anderen Lernenden und der Umwelt beim Lernen zu unterstützen, stößt aber aufgrund geringer Replizier- und Planbarkeit in der Praxis regelmäßig an Grenzen. Innovative digitale Lösungen aufbauend auf Erkenntnissen aus der Kollaborationsforschung angewandt auf Lernen eröffnen innovative Gestaltungsmöglichkeiten für die Gestaltung von Lehr-Lern-Prozessen zum Wissenserwerb und -transfer und Erwerb berufsrelevanter Kompetenzen.

In der von Frau Oeste-Reiß verfassten Arbeit werden Erkenntnisse aus der Kollaborationsforschung, dem sog. „Collaboration Engineering", zum systematischen Entwurf und Durchführen interpersonaler Zusammenarbeit herangezogen, um eine replizierbare und planbare Anwendung von Peer Lernen in der Praxis zu ermöglichen. Die Arbeit beschreibt diese Grundlagen und liefert Einblicke in das systematische Gestalten von wiederverwendbaren Ansätzen zur Förderung des Peer Lernens. Dazu werden in der Arbeit Referenzprozesse zum Wissenserwerb und -transfer vorgeschlagen, entwickelt und evaluiert. Nicht-intuitive Designentscheidungen und Kollaborationsexpertise werden in den Referenzprozessen so gebündelt, dass Lernende befähigt werden, auf ein gemeinsames Ziel hinzuarbeiten und gemeinsam hochwertige

Lösungen zu generieren sowie Lerneffekte zu erzielen, die ad hoc Kollaboration und Individualleistungen übertreffen. Vor diesem Hintergrund widmet sich die Arbeit drei zentralen Aufgabenstellungen: (1) der Analyse der Anwendungsdomäne und der Schaffung notwendiger Rahmenbedingungen für Peer Lernen; (2) der Konzeption eines Ansatzes zur Entwicklung von Referenzprozessen zur Initiierung von Peer Lernen; (3) dem Design, dem Einsatz und der Evaluation von Referenzprozessen zur Initiierung von Peer Lernen. Methodisch folgt die Arbeit einem gestaltungsorientierten Vorgehen und beschreibt anhand dessen die verschiedenen Studien.

Das Themenfeld der Arbeit ist in Praxis und Wissenschaft von hoher Relevanz. Die Arbeit verdeutlicht das Gesamtbild des Theorietransfers aus dem Collaboration Engineering in die Anwendungsdomäne des Peer Lernens sehr anschaulich. Mit den eigenen Ansätzen sowie den verschiedenen prototypischen Umsetzungen nebst umfangreichen Evaluationen werden die Eigenbeiträge der Arbeit klar herausgearbeitet. Die Arbeit zeigt hierbei das Potenzial des Collaboration Engineering für die Entwicklung kollaborativer Lernformate bzw. Lernszenarien anschaulich auf. Frau Oeste-Reiß betritt mit ihrer Arbeit eine Anwendungsdomäne, in der große Teile der behandelten Thematik Neuland sind und sie liefert wichtige Anregungen sowohl für die wissenschaftliche Diskussion als auch für die praktische Anwendung von Methoden zur systematischen Entwicklung von kollaborativen Lernszenarien. Ihr großer Fleiß und ihre Vielfalt an relevanten wissenschaftlichen Leistungen sind insbesondere auch in der hohen Anzahl an hochwertigen Publikationen im Promotionsthema anschaulich dokumentiert. Der Arbeit von Sarah Oeste-Reiß wünsche ich daher die ihr gebührende Aufmerksamkeit und Verbreitung.

Prof. Dr. Jan Marco Leimeister

Vorwort

Meine mehrjährige Tätigkeit am Fachgebiet Wirtschaftsinformatik der Universität Kassel und des Wissenschaftlichen Zentrums für Informationstechnik-Gestaltung (ITeG) eröffnete mir die Möglichkeit, dieses Promotionsvorhaben zu realisieren.

Besonderer Dank gilt meinem akademischen Mentor Prof. Dr. Jan Marco Leimeister, der mich mit seinen inspirierenden Anregungen, seinen kritischen Kommentaren sowie seiner wertvollen Unterstützung stets fachlich gefordert und gefördert sowie mir die Freiheit eingeräumt hat, meine wissenschaftlichen Interessen zu verfolgen. Prof. Dr. Gerhard Schwabe gilt mein besonderer Dank für die Übernahme des Zweitgutachtens. Weiterhin gilt mein besonderer Dank Prof. Dr. Eva Alice Christiane Bittner und Prof. Dr. Ali Sunyaev für die Mitgliedschaft in der Promotionskommission. Prof. Dr. Robert O. Briggs bin ich für die wertvollen Einblicke tief verbunden, die ich während meines Forschungsaufenthaltes an der San Diego State University (USA) gewinnen und im Rahmen weiterer inspirierender wissenschaftlicher Diskurse fortführen durfte.

Besonderer Dank gilt darüber hinaus meinen Kolleginnen und Kollegen der Universität Kassel sowie meinen Co-Autorinnen und Co-Autoren für die immer heiteren und spannenden Diskurse sowie die vielen gemeinsamen Erlebnisse. Hier ist vor allem Prof. Dr. Matthias Söllner zu nennen. Mein Dank gilt darüber hinaus meinen studentischen Hilfskräften und Studienteilnehmenden, ohne deren Engagement und Offenheit meine Forschung in dieser Weise kaum möglich gewesen wäre.

Vor allem danke ich meiner Familie und meinen Freunden, die mich stets mit einer motivierenden Neugier, Fröhlichkeit und Ausgelassenheit begleitet und mir so einen wertvollen Ausgleich zur Dissertation geschenkt haben. Mein ganz herzlicher Dank gilt meinen wunderbaren Eltern, Ingrid und Arndt Oeste, für ihre immerwährende Unterstützung auf meinem Ausbildungsweg. Patrick, dem bezaubernden Wegbegleiter an meiner Seite, danke ich von Herzen für sein unermüdliches Verständnis auf der abenteuerlichen Reise der letzten Jahre.

Alle diese Menschen haben durch ihr wertschätzendes und konstruktives Wesen, durch ihre Neugier und ihre Unvoreingenommenheit diesen prägenden Lebensabschnitt bereichert sowie mit großartigen Erinnerungen zum Strahlen gebracht haben.

Sarah Oeste-Reiß

Zusammenfassung

Ziel: Die Digitalisierung durchdringt und verändert zunehmend alle Lebensbereiche und damit verbundene Arbeitsroutinen. Damit einhergehend steigen die Bedeutung des lebenslangen Lernens und der Bedarf von Ansätzen, die Menschen beim Transfer von Wissen sowie beim Aufbau von Wissen auf hohen Lernzielebenen, sog. 'higher-level learning‘ (HLL), unterstützen. Die zunehmende Verfügbarkeit von Informationen ermöglicht einen flexiblen Zugriff auf Faktenwissen losgelöst von zeitlichen und räumlichen Restriktionen. Damit einhergehend sinkt die Bedeutung von Faktenwissen. Folglich verändern sich die Anforderungen an die Qualifikation von Wissensarbeitern. So werden die Leistung und Qualifikation eines Wissensarbeiters heute daran gemessen, inwieweit dieser über Wissen auf hohen Lernzielebenen verfügt und Kompetenzen in den Bereichen kritisches Denken, Problemlösen sowie Kommunikations- und Kooperationsfähigkeit aufgebaut hat (David/Foray 2003; García-Aracil/Van der Velden 2008; Johnson et al. 2015). Universitäten sind angehalten, qualitativ hochwertige Bildung und Lehr-/Lernkonzepte anbieten, welche die Wissensarbeiter von morgen beim Aufbau dieser Kompetenzen und Fähigkeiten unterstützen. Im Bereich des sog. ‚Peer Learning‘ (PL) existieren Ansätze, die einen reziproken Austausch von Erkenntnissen sowie Feedback zwischen Lernenden fördern (Topping 2005). Geeignet ist PL jedoch vornehmlich für kleinere Gruppengrößen, so dass sich eine Anwendung, z.B. in universitären Massenlehrveranstaltungen als problematisch erweist. Dies liegt darin begründet, dass der Dozierende als Coach fungiert, die Lernenden in ihrem Lernerlebnis unterstützt und auf unvorhergesehene Lernaktivitäten spontan reagiert. Aus Perspektive konstruktivistischer Lerntheorien sollen Interaktionen der Lernenden nicht vorgegeben werden, sondern ad hoc entstehen, um den Lernenden ein größtmögliches Lernerlebnis zu gewährleisten (Bodner 1986; Poplin 1988; Jones/Brader-Araje 2002). Im Gegensatz dazu liefert die Kollaborationsforschung jedoch Erkenntnisse, dass die meisten Individuen, so auch Lernende, nicht über ein intuitives Verständnis von effektiver Kollaboration bzw. Zusammenarbeit verfügen. Ohne Vorgaben ist die Kollaboration in Gruppen deshalb meistens ineffektiv (Briggs et al. 2013). Die meisten Lernenden sind weder Experten bei der Gestaltung effektiver Lernerlebnisse noch bei der spontanen Ausgestaltung effektiver Aktivitäten zur Kollaboration. Kollaboration erfordert Prozesse, welche die kognitiven Beanspruchungen und Ablenkungen minimieren sowie gleichzeitig Kommunikation, logisches Denken sowie den Informationsaustausch fördern. Ein Lösungsansatz zur Überwindung dieser Problemstellung besteht daher in der Entwicklung von replizierbaren kollaborativen Ansätzen zur Förderung von Wissenstransfer und HLL.

Um jedoch einen solchen Lösungsansatz zu entwickeln, existieren drei zentrale Herausforderungen: (1) Die Analyse des Anwendungsfeldes PL sowie die Schaffung von Bedingungen zur Implementierung von PL; (2) Die Konzeption eines Ansatzes zur systematischen Entwicklung wiederverwendbarer Referenzprozesse zur Förderung von PL; (3) Die Erforschung der Effektivität von Referenzprozessen für PL (Konzeptentwicklung, Implementierung und Evaluation).

Forschungsansatz: Um eine Antwort auf diese Herausforderung zu geben, werden in dieser Dissertation verschiedene Studien vorgestellt. Jede Studie beschreibt ein Gestaltungsartefakt und adressiert eine spezifische Forschungsfrage samt definierten Gestaltungszielen. Daher folgt die Forschungsstrategie einem gestaltungsorientierten Vorgehen und folgt sog. ‚Design Science Research' (DSR) Prinzipien. Abhängig von der Zielsetzung (forschungsleitenden Fragestellung) und den Gestaltungszielen der jeweiligen Studie, wird unter anderem Bezug auf eine Problemsituation (sog. ‚Relevance Cycle') sowie auf die zugehörige Theoriebasis (sog. ‚Rigor Cycle') genommen. Außerdem wird jeweils ein sog. ‚Design/Evaluate Cycle' beschrieben, der das Gestaltungsartefakt der jeweiligen Studie soezifiziert. Auf diese Weise wird eine praxis- und theoriegeleitete Entwicklung und Evaluation des Gestaltungsartefaktes gewährleistet. Weiterhin wird für jede Studie der Theoriebeitrag in Bezug auf eine Klassifizierung nach der Art präskriptiver Wissensbeiträge aufgezeigt.

Ergebnisse: In Anlehnung an die beschriebenen Herausforderungen zeigt die Dissertation fünf zentrale Ergebnisse auf: Das *Flipped-Classroom Concept (Kapitel 4)* stellt einen innovativen Lehr-/ Lernansatz dar, der den Lernenden aktiviert und die nötigen Rahmenbedingungen für PL in Massenlehrveranstaltungen schafft. Dieses Konzept beschreibt den Lehr-/Lernansatz in abstrakter Weise und liefert Hinweise, wie dieser instanziiert werden kann. Die Ergebnisse einer qualitativen Inhaltsanalyse verdeutlichen die Rahmenbedingungen von PL und zeigen Grenzen konstruktivistisch geprägter PL Aktivitäten in Massenlehrveranstaltungen auf. Der *Peer-Learning Reference-Process Approach (PL-RPA)* (Kapitel 5) beschreibt einen konzeptionellen Ansatz zur Erstellung von Referenzprozessen für PL. Es werden Forschungsthesen hergeleitet, die den Einsatz von CE-Mechanismen im Anwendungsfeld von PL befürworten. Weiterhin werden Kategorien von Anforderungen aus den Bereichen PL und CE aufgezeigt und im PL-RPA zusammengeführt. Das *Peer-Learning Process Design (PL-PD)* (Kapitel 6.1) beschreibt einen Referenzprozess für PL zur Stimulierung von Wissenstransfer und -dokumentation. Die Evaluation, bestehend aus Simulationen, Walkthroughs und Pilottests, zeigt u.a. einen Wissenszuwachs bei den Teilnehmern des

Referenzprozesses auf. Das PL-PD wurde innerhalb verschiedener Gruppen mit Studierenden getestet, wobei eine Gruppe papierbasierte Werkzeugunterstützung, die andere IT-basierte Werkzeugunterstützung erhielt. Beide Gruppen zeigen ähnliche Ergebnisse. Der *Peer-Learning Pattern Approach (PL-PA) (Kapitel 6.2)* beschreibt zwei leichtgewichtigen Referenzprozesse für PL, wobei der eine mit dem sog ‚Critical Thinking Pattern (CTP)' kritisches Denken und der andere mit dem sog. ‚Problem-Solving Pattern' Problemlösekompetenzen adressiert. Da das Ziel der Studie in der Befähigung von Dozierenden in der Anwendung von PL-Aktivitäten bestand, wurde der PL-PA von verschiedenen Dozierenden angewendet. Die Evaluation bestehend aus einer anforderungsbasierten Evaluation, Simulationen, Walkthroughs und Pilottests, zeigt bei allen Gruppen vergleichbare Ergebnisse und untermauert die Prognostizierbarkeit und Übertragbarkeit des PL-PA. Die *HLL Design Theory (Kapitel 6.3)* fokussiert die Steigerung von HLL in Massenlehrveranstaltungen und die Bündelung von Kollaborationsexpertise in einem Referenzprozess, so dass Dozierende und Lernende PL Aktivitäten in replizierbarer Weise ausführen können. Die Evaluation der HLL Design Theory ist durch ein online quasi Experiment in einer Massenlehrveranstaltung gekennzeichnet. Studierende der Treatmentgruppe folgen dem Referenzprozess für HLL während Studierende der Kontrollgruppe ihre kollaborativen PL Aktivitäten zur Lösung einer komplexen Fallstudienaufgabe ad hoc gestalten. Die Ergebnisse zeigen höhere HLL Effekte in der Treatmentgruppe und leisten damit einen wesentlichen Erkenntnisgewinn zur Beantwortung der zentralen Fragestellung der Dissertation.

Forschungsimplikationen: Die Ergebnisse der Dissertation liefern Theoriebeiträge im Bereich des PL und des CE. Das *Flipped-Classroom Concept* als innovatives Lehr-/Lernkonzepts für Massenlehrveranstaltungen repräsentiert eine ‚Theory of Design and Action' das zeigt, wie Lernende aktiviert und die Rahmenbedingungen für PL in Massenlehrveranstaltungen geschaffen werden können. Die Theoriebeiträge umfassen u.a. Anforderungen und Designprinzipien zur Neugestaltung traditioneller Massenlehrveranstaltungen und eine abstrakte Beschreibung eines Referenzprozesses für das Lehr-/Lernkonzept des Flipped Classroom. Ein weiter Theoriebeitrag besteht in der Beschreibung der Instanziierung des Flipped-Classroom Concept in Form eines Moodle Prototypen. Der *PL-RPA* als Ansatz zur Entwicklung von Referenzprozessen für PL repräsentiert Komponenten einer ‚Theory of Design and Action'. Mit der Schaffung von konzeptionellen Grundlagen für die Anwendung von CE Mechanismen im Anwendungsfeld PL umfasst der PL-RPA zwei zentrale Theoriebeiträge. In einem Modell werden die Forschungsthesen zur Gestaltung des PL-RPA und der damit einhergehenden Verknüpfung von Mechanismen aus dem Bereich des PL und CE beschrieben. Der PL-RPA selbst repräsentiert eine Methodik in Form eines Vorgehensmodells zur Gestaltung von Referenzprozessen für PL. Das *PL-PD* zur Stimulierung kollaborativen Transfers und Dokumentation von Wissen liefert Theoriebeiträge in Form einer ‚Nascent Design Theory'. Die Theoriebeiträge umfassen u.a. Anforderungen und die abstrakte Beschreibung eines Referenzprozesses in Form eines Facilitation Process Models sowie einer internen Agenda als generalisierbare Lösung. Der *PL-PA* liefert präskriptives Wissen in Form verschiedener Komponenten einer ‚Design Theory'. Theoriebeiträge sind u.a. Anforderungen zur Befähigung von Dozierenden zur Stimulierung von PL Aktivitäten in den Bereichen kritisches Denken und Problemlösekompetenzen sowie einer abstrakten Beschreibung der beiden Referenzprozesse in Form einer internen Agenda. Weiterhin liefert der PL-PA Prinzipien zur Implementierung der Referenzprozesse im Feld, indem die von Dozierenden vorzubereitenden Rahmenbedingungen für die Anwendung des PL-PA beschrieben werden. Die *HLL Design Theory* zur Steigerung von HLL in Massenlehrveranstaltungen repräsentiert eine ‚Design Theory' samt aller Komponenten präskriptiven Wissens. Sie liefert u.a. Theoriebeiträge in Form eines Konstruktes, welches Wissenszuwachs beschreibt; des HLL Process, welcher einen Referenzprozess für HLL in Massenlehrveranstaltung als generalisierbare Lösung beschreibt; der HLL Methodology, welche die Prinzipien zur Instanziierung des HLL Process spezifiziert; der HLL-PSA, welche die prototypische Implementierung in einer Massenlehrveranstaltung unter Einsatz von Moodle und Google Docs beschreibt.

Praktische Implikationen: Die Ergebnisse der Dissertation sind für Praktiker (z.B. Dozierende und Manager/innen) relevant, die im Bereich der universitären Lehre und/oder des betrieblichen Wissensmanagements bzw. der Personalentwicklung tätig sind. Die Struktur der Arbeit liefert Praktikern gezielte Anknüpfungspunkte entsprechend ihrer Bedarfe. Jede Studie verweist dabei u.a. auf die forschungsleitende Fragestellung, die Gestaltungsziele, die Beschreibung des Gestaltungsartefaktes sowie die prototypische Implementierung und liefert damit Praktiker einen anschaulichen Überblick samt Handlungsimplikationen. Das *Flipped-Classroom Concept* liefert Einblicke in einen innovativen Lehr-/Lernansatz, der die Neugestaltung universitärer Massenlehrveranstaltung beschreibt. Der *PL-RPA* liefert Praktikern eine Methodik, um Referenzprozesse für PL zu entwickeln. Das *PL-PD* liefert Praktikern einen Referenzprozess, um kollaborativen Wissenstransfer und -dokumentation zu initiieren. Der *PL-PA* liefert Praktikern zwei Referenzprozesse für die Stimulierung von Kompetenzen zum kritischen Denken sowie Problemlösen. Die *HLL Design Theory* liefert Praktikern mit der abstrakten Beschreibung eines Referenzprozesses, einer Methodik zur Implementierung sowie einem Prototyp, einen Ansatz, um HLL Effekte in Massenlehrveranstaltungen zu initiieren.

Abstract

Purpose: Approaches for enhancing knowledge transfer and higher-level learning (HLL) are becoming increasingly important in the digital age. With the increasing availability of information – anytime, anyplace – factual knowledge is now plentiful and inexpensive. Performance of today's knowledge workers depends more heavily on the degree to which they have mastered higher-level thinking skills such as critical thinking, problem-solving, communication, and cooperation (David/Foray 2003; García-Aracil/Van der Velden 2008; Johnson et al. 2015). Therefore, universities have to provide high-quality education that copes with these demands. Peer learning (PL) literature offers useful approaches to foster the reciprocal exchanges of understanding and feedback between learners (Topping 2005). PL works best in small groups and is not well suited to large class sizes since the lecturer acts as a coach and provides guidance on unexpected learner activities. In addition, learning literature posits that PL interactions should not be prescribed; they should be emergent and ad hoc so as not to stifle learning (Bodner 1986; Poplin 1988; Jones/Brader-Araje 2002). In contrast, field experiences suggest that most individuals do not have an intuitive grasp of how to collaborate effectively, so, left to themselves, most groups tend to be ineffective (Briggs et al. 2013). Furthermore, most learners are not experts at designing effective learning experiences and ad hoc collaboration. Collaboration requires processes that minimize cognitive load and distraction, while fostering communication, reasoning, and information access. Therefore, developing resusable approaches that enhance collaborative knowledge transfer and HLL seem to be a solution to cope with this situation. However, three central challenges occur: (1) Analyzing the application domain of PL and creating the conditions to implement PL; (2) Developing an approach to systematically design reusable PL activities in the form of reference processes for PL; (3) Analyzing the effectivity of reference processes for PL (design, implementation, and evaluation).

Research Approach: To meet these challenges, the thesis describes several studies, each focusing on developing a design artifact. Therefore the methodological foundation of the thesis is Design Science Research (DSR). Each of the studies follows formal demands of DSR. Depending on the aim and design goals of the studies, each study inter alia refers to the problem situation (relevance cycle) as well as the theoretical and conceptual foundations (rigor cycle) in order to inform the design choices by the environment and by the knowledge base. Moreover a design/evaluate cycle specifying the design artifact is also described in the studies. To refer to the knowledge

contributions, each studiy classifies those as prescriptive knowledge and refers to the type of theory.

Findings: Overall, thesis provides five core findings that meet the three described challenges. First, the *Flipped-Classroom Concept (chapter* 4*)* describes an innovative teaching-learning concept that activates the learner and creates the conditions for PL in large classes. The Flipped-Classroom Concept illustrates how to redesign the IS classroom and build an exemplary instance. The results from a qualitative content analysis provide insights into the conditions of PL activities in large classes and thus, clarify the underlying set of unsolved problems in this thesis. Second, the *Peer-Learning Reference-Process Approach (PL-RPA) (chapter* 5*)* describes a conceptual approach for designing reference processes for PL. The PL-RPA describes the conceptual basis for using CE mechanisms to design PL activities by deriving necessary research propositions. The PL-RPA also illustrates categories of requirements and the sequence of engineering activities that need to be addressed in order to design reference processes for PL. Third, the *Peer-Learning Process Design (PL-PD) (chapter 6.1)* presents a reference process for PL as a collaborative work practice for knowledge transfer and documentation. The results from a multi-method evaluation comprising simulations, walkthroughs, and pilot schemes show expertise increases in the knowledge base of the participants. Moreover, the PL-PD was tested within several groups of students – one group followed the PL-PD with paper-based and the other group followed the PL-PD with IT-based tool support. Both groups show similar results. Fourth, the *Peer-Learning Pattern Approach (PL-PA) (chapter 6.2)* comprises two patterns that enhance PL activities in the disciplines of critical thinking and problem-solving. Since the aim of the study was to empower lecturers to enhance PL activities in the mentioned disciplines, the PL-PA was conducted in the field by different lecturers. The results of an evaluation comprising a requirement-based evaluation, simulations, walkthroughs, and pilot schemes with different groups show comparable results among all groups. Those results indicate inter alia that the PL-PA with its two patterns is predictable and transferable. Fifth, the *HLL Design Theory (chapter 6.3)* aims at enhancing HLL in large classes and at packaging facilitation expertise in the design, so that lecturers can execute and learners can follow a well-designed work practice. The evaluation is characterized by an online quasi experiment in a large class. The treatment group followed the engineered reference process of the HLL Design Theory while the control group did not follow the engineered PL activities and, thus, was free in their collaborative activities. The results indicate higher HLL effects in the treatment group compared to those in the control group. These results strengthen the insights for the main research goal of the thesis and prove that packaging collaboration expertise in reference processes for PL has the potential to leverage the power of PL.

Research Implications: The studies of the thesis and their results make contributions to the knowledge base of PL and CE. The *Flipped-Classroom Concept* as an innovative teaching-learning concept represents a 'theory of design and action'. It redesigns the IS classroom and describes a blueprint of a teaching-learning concept that overcomes the lack of interaction and provides the conditions for implementing PL. Prescriptive knowledge contributions are inter alia requirements and design principles that illustrate how to redesign traditional large classes as well as an abstract blueprint of the teaching-learning concept. An additional knowledge contribution is represented by the description of a prototype of the Flipped-Classroom Concept and its instantiation in a large class by using Moodle. The *PL-RPA* for designing reference processes for PL makes contributions toward several components of a 'theory for design and action'. It develops the conceptual foundations for systematically designing PL activities by creating an understanding of using CE mechanisms in the domain of PL. Therefore, the PL-RPA consists of a model that describes the research propositions for PL-RPA and thus, the foundations to apply CE in the domain of PL as well as a method (technique) that describes the procedures for designing reference processes for PL. The *PL-PD* for promoting collaborative knowledge transfer and documentation makes a contribution in the form of a 'nascent design theory'. Prescriptive knowledge contributions inter alia comprise generalizable requirements for reference processes stimulating collaborative knowledge transfer and an abstract description of the design of the reference process of PL-PD as a generalizable solution. The latter is illustrated by a facilitation process model and an internal agenda. The *PL-PA* provides prescriptive knowledge contributions toward several components of a 'design theory' for empowering lecturers who lack validated out-off-the-box techniques to initiate PL activities among learners in the disciplines of problem-solving and critical thinking. The prescriptive knowledge contributions inter alia comprise generalizable requirements for empowering lecturers to enhance PL activities as well as an abstract description of the design of the reference processes of PL-PA with regard to its two patterns. The description of the patterns serves as a generalizable solution. Each is represented by an internal agenda. In addition, the PL-PA provides prescriptive knowledge in the form of principles of implementation. It refers to the conditions that lecturers have to prepare in order to use the PL-PA and to build an exemplary instance. The *HLL Design Theory* for enhancing HLL in large classes represents a contribution in the form of a holistic 'design theory'. Prescriptive knowledge contributions are inter alia inherent in the form of a construct that classifies increases in learners' domain knowledge with regard to HLL effects; an abstract description of the HLL Process that describes a blueprint of the reference process for enhancing HLL in large classes; the HLL Methodology that describes principles of implementation for building exemplary instances from the HLL Process; the HLL-PSA that serves as an exemplary instance of the HLL Process and describes a prototype using Moodle and Google Docs for a large class setting.

Practical Implications: The results of the thesis are relevant for practitioners (e.g. lecturers, manager) who deal with teaching, knowledge management or human resource management. The structure of the thesis and the description of the studies supports them find entry points for using the results for their demands in practice. More precisely, the studies provide an overview of the research question, the design goals, the description of the design artifacts, and the prototypes as exemplary instances. This supports practitioners to use the results for their practical pruposes. The *Flipped-Classroom Concept* provides those audiences with insights into an innovative teaching-learning concept for large classes that overcomes the lack of interaction. The *PL-RPA* gives them an approach for designing reference processes for PL. The *PL-PD* examines the effectivity of reference processes for PL and provides practitioners with a collaborative work practice for enhancing knowledge transfer and documentation. This provides practitioners with a technique for qualifying knowledge workers through knowledge transfer as well as retaining valuable knowledge from knowledge workers. The *PL-PA* gives practitioners two modular reference processes – one focusing on training problem-solving abilities and the other on training critical thinking abilities. The *HLL Design Theory* provides lecturers with a technique for enhancing HLL in large classes. Practitioners receive an abstract description of a reference process for enhancing HLL in large classes in the form of the HLL Process. They also receive the HLL Methodology that supports them to build their own exemplary instances of the HLL Process.

Full List of Publications

During my time as at the Department of Information Systems as student assistant and later as PhD student, I authored and co-authored the following publications:

(Oeste-Reiß et al. submit to)	**Oeste-Reiß, S.; Briggs, R. O.; Söllner, M.; Leimeister, J. M.** (submit to): Towards a Design Theory for Enhancing Higher-Level Learning in Large University Classes with Collaborative Learning Experiences. In: Journal of Management Information Systems (JMIS), (submit to).
2017	
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Table of Contents

Geleitwort V

Vorwort VII

Zusammenfassung VIII

Abstract XIII

Full List of Publications XVII

List of Figures XXVI

List of Tables XXVIII

List of Abbreviations XXXI

1 INTRODUCTION 1

1.1 Problem Statement 1

1.2 Solution Statement and Research Questions 5

1.3 Structure of the Thesis 11

1.3.1 Thesis Outline and Summary of Chapters 11
1.3.2 Chapters in Relation to Research Questions and Publications 15

2 THEORETICAL FOUNDATIONS 17

2.1 Pedagogical Foundations of Peer Learning 17

2.1.1 Constructivist Learning Theory 17
2.1.2 Peer Learning and Related Approaches 19
2.1.3 Bloom's Revised Taxonomy and Higher-Level Learning 21
2.1.4 Expertise as an Indicator of Knowledge Increases 22

2.2 Conceptual Foundations of Collaboration Engineering 24

2.2.1 Conceptual Foundations and Definitions 25
2.2.2 Roles in Collaboration Engineering 27
2.2.3 Six-Layer Model of Collaboration 28
2.2.4 Documentation of Collaborative Processes Designs 30
2.2.5 Process Restrictions of Collaborative Work Practices 32
2.2.6 Indicators to Measure the Quality of a Collaborative Work Practice 32

3 RESEARCH STRATEGY AND METHDOLOLOY 34

3.1 Scientific Epistemology 34

3.2 Design Science Research 36
3.2.1 Three Cycle View of Design Science Research 36
3.2.2 Theory in Information Systems Research 38
3.2.3 Design Artifacts and its Knowledge Contributions 39
3.3 Methods to Create and Evaluate Design Artifacts 42
4 APPLICATION DOMAIN OF PEER LEARNING: .... Flipped-Classroom Concept – Redesigning Large Classes .... to Activate the Learner and to Create Conditions for Peer Learning 44
4.1 Flipped-Classroom Concept in the Context of the Thesis 44
4.2 Study Outline and Research Approach 45
4.3 Relevance and Objective of the Study 47
4.3.1 Challenges of the Application Domain of Large University Classes 47
4.3.2 Objective of the Study and Design Goals 49
4.4 Theoretical Foundations: Flipped Classroom, MOOC, and SPOC 50
4.5 The Flipped-Classroom Concept 52
4.5.1 Generalizable Requirements for the Flipped-Classroom Concept 52
4.5.2 Theory-Driven Design Principles from Peer Learning 53
4.5.3 The Flipped-Classroom Concept as a Generalizable Solution 57
4.5.3.1 Overview: The Teaching-Learning Cycle 57
4.5.3.2 Phase 1: Self-Learning (Online) 59
4.5.3.3 Phase 2: Peer Learning (Online) 60
4.5.3.4 Phase 3: Transfer Phase (Presence) 62
4.5.3.5 Phase 4: Application Phase (Presence) 63
4.6 Flipped-Classroom Prototype as Exemplary Instance 64
4.6.1 Context of the Flipped-Classroom Prototype 64
4.6.2 Phase 1: Self-Learning (Online) 66
4.6.3 Phase 2: Peer Learning (Online) 67
4.6.4 Phase 3: Transfer Phase (Presence) 69
4.6.5 Phase 4: Application Phase (Presence) 69
4.7 Evaluation of the Flipped-Classroom Prototype 70
4.7.1 Study Structure and Data Triangulation 70
4.7.1.1 Context and Participants Background 70

4.7.1.2 Selection of Participants and Data Collection 70
4.7.2 Qualitative Content Analysis 71
4.7.3 Results 75
4.7.3.1 Category – Teaching Learning Approach 75
4.7.3.2 Category – Phase 1: Self-Learning (Online) 77
4.7.3.3 Category – Phase 2: Peer Learning (Online) 77
4.7.3.4 Category – Phase 3: Transfer Phase (Presence) 80
4.7.3.5 Category – Phase 4: Application Phase (Presence) 81

4.8 Discussion, Recommendations for Action, and Future Research 82

4.8.1 DG 1 – Overcome the Lack of Interaction 82
4.8.2 DG 2 – Provide the Conditions for Peer Learning 84
4.8.3 IT Support in the Flipped-Classroom Concept 85
4.8.4 Recommendations for Action to Use the Flipped-Classroom Concept.. 86

4.9 Limitations, Conclusion, and Contribution 87

5 PEER-LEARNING REFERENCE-PROCESS APPROACH (PL-RPA): Engineering Peer- Learning Reference Processes for Generating High-Quality Learning Materials 91

5.1 Peer-Learning Reference-Process Approach in the Context of the Thesis 91

5.2 Research Approach and Study Outline 92

5.3 Problem Statement and Design Goal 92

5.4 Theoretical Background 94

5.4.1 Related Work in Peer Learning 94
5.4.2 Related Work in Collaboration Engineering 97

5.5 The Peer-Learning Reference-Process Approach 98

5.5.1 Guiding Idea for Peer-Learning Reference Processes 98
5.5.2 Peer-Learning Reference-Process Approach 100

5.6 Contribution, Conclusion, Limitations, and Future Research 104

6 REFRENCE PROCESSES FOR PEER LEARNING (I–III): DESIGN, IMPLEMENTATION, EVALUATION 106

6.1 Peer-Learning Process Design for Knowledge Documentation to Leverage the Power of Collaborative Knowledge Transfer (PL-PD) .. 106

6.1.1 Peer-Learning Process Design in the Context of the Thesis 106
6.1.2 Study Outline and Research Approach 107
6.1.3 Problem Statement and Design Goals 109
6.1.4 Related Work 111
6.1.4.1 Collaboration Engineering 111
6.1.4.2 Peer Learning 113
6.1.4.3 Working Definition of Knowledge Transfer 114
6.1.5 The Peer-Learning Process Design 116
6.1.5.1 Generalizable Requirements for the Peer-Learning Process Design 117
6.1.5.2 The Peer-Learning Process Design as Generalizable Solution 118
6.1.6 Validating the Peer-Learning Process Design 126
6.1.6.1 Methodology 126
6.1.6.2 Results 130
6.1.7 Discussion 133
6.1.8 Limitations and Future Research 136
6.1.9 Conclusion and Contribution 137

6.2 Peer-Learning Pattern Approach for Empowering Lecturers to Enhance Collaboration among Learners in the Disciplines of Problem-Solving and Critical Thinking Regardless of Class Size (PL-PA) 139

6.2.1 Peer-Learning Pattern Approach in the Context of the Thesis 139
6.2.2 Study Outline and Research Approach 140
6.2.3 Problem Statement and Design Goals 141
6.2.4 Theoretical Foundations of Problem-Solving and Critical Thinking ... 144
6.2.5 The Peer-Learning Pattern Approach 146
6.2.5.1 Generalizable Requirements to Empower Lecturers for Stimulating Peer Learning 146
6.2.5.2 The Peer-Learning Pattern Approach as Generalizable Solution 147
6.2.6 Validating the Peer-Learning Pattern Approach 154
6.2.6.1 Methodology 154
6.2.6.2 Results 157
6.2.7 Discussion 161
6.2.8 Limitations and Future Research 162
6.2.9 Contribution, and Conclusion 163

6.3 Design Theory for Enhancing Higher-Level Learning in Large University Classes (HLL Design Theory) ... 165

6.3.1 The HLL Design Theory in the Context of the Thesis ... 165
6.3.2 Study Outline and Research Approach ... 166
6.3.3 Problem Statement and Design Goals ... 167
6.3.4 Kernel Theories for Achieving Higher-Level Learning by Collaboration ... 169
6.3.4.1 Phenomenon of Interest in the Study ... 170
6.3.4.2 Basics in Peer Learning ... 171
6.3.4.3 Basics in Collaboration Engineering ... 172
6.3.5 Generalizable Requirements for Enhancing Higher-Level Learning in Large University Classes ... 173
6.3.6 The HLL Reference Process (HLL Process) ... 176
6.3.6.1 Collaboration Goal ... 177
6.3.6.2 Step 1: Registration – Individual (Asynchronous) ... 178
6.3.6.3 Step 2: Knowledge Test – Individual (Asynchronous) ... 179
6.3.6.4 Step 3: Brainstorming - Subgroups (Synchronous) ... 181
6.3.6.5 Step 4: Converging – Breakout Groups (Synchronous) ... 183
6.3.6.6 Step 5: Reporting – Breakout Groups (Synchronous) ... 185
6.3.7 The HLL Reference Process Methodology (HLL Methodology) ... 187
6.3.7.1 Overview of the HLL Process ... 188
6.3.7.2 Constraints of the HLL Process to Build a HLL-PSA ... 188
6.3.7.3 Scope and Content of the HLL Process to Build a HLL-PSA ... 190
6.3.8 The HLL Process Support Application (HLL-PSA) ... 192
6.3.8.1 Characteristics of the Case, Learning Tasks, and Learner Deliverable ... 192
6.3.8.2 Specifics of the Breakdown Structure of Groups ... 193
6.3.8.3 HLL-PSA - Step 1: Registration – Individual (Asynchronous) ... 194
6.3.8.4 HLL-PSA - Step 2: Knowledge Test – Individual (Asynchronous) ... 194
6.3.8.5 HLL-PSA - Step 3: Brainstorming – Subgroups (Synchronous) ... 195
6.3.8.6 HLL-PSA - Step 4: Converging – Breakout Groups (Synchronous) 196
6.3.8.7 HLL-PSA - Step 5: Reporting – Breakout Groups (Synchronous) .. 197
6.3.9 Validating the HLL Design Theory ... 198
6.3.9.1 Requirement-Based Evaluation ... 198
6.3.9.2 Study Structure of the Online Quasi Experiment ... 200

6.3.9.3 Differences Between the Control and Treatment Sample 203
6.3.9.4 Measures 204
6.3.9.5 Hypothesis and Exploratory Research Questions 208

6.3.10 Results 210
6.3.11 Discussion 214
6.3.11.1 Design Goal 1 - Enhancing HLL in Large University Classes 214
6.3.11.2 Design Goal 2 - Packaging Sufficient Collaboration Expertise 218

6.3.12 Contribution, Limitations and Future Research 219
6.3.13 Conclusion 222

7 LIMITATIONS AND SCOPE OF THE THESIS 224

8 SUMMARY OF CONTRIBUTIONS 229

8.1 Knowledge Contributions and the Three Sieves of Socrates 229

8.2 Contributions to the Knowledge Base of Peer Learning and Collaboration Engineering 230

8.2.1 The Flipped-Classroom Concept 231
8.2.2 The Peer-Learning Reference-Process Approach 232
8.2.3 Reference Process (I) – Peer-Learning Process Design 233
8.2.4 Reference Process (II) – Peer-Learning Pattern Approach 234
8.2.5 Reference Process (III) – HLL Design Theory 235

8.3 Contributions to Practice 237

9 DIRECTIONS FOR FUTURE RESEARCH 240

REFERENCES 244

APPENDIX 259

Appendix A. Peer-Learning Process Design 260

Appendix B. HLL Design Theory 276

List of Figures

Figure 1: Structure of the Thesis 11
Figure 2: Kolb's Learning Cycle 19
Figure 3: Cognitive Process Dimensions of Bloom's Revised Taxonomy 21
Figure 4: Definition of Collaboration 25
Figure 5: The Six-Layer Model of Collaboration 28
Figure 6: Elements of the Facilitation Process Model 31
Figure 7: Design Science Research Cycles 37
Figure 8: Research Approach for Developing the Flipped-Classroom Concept 45
Figure 9: Teaching-Learning Cycle of the Flipped-Classroom Concept 57
Figure 10: Flipped-Classroom Prototype: Teaching-Learning Cycle (Phase 1) 67
Figure 11: Flipped-Classroom Prototype: Teaching-Learning Cycle (Phase 2) 68
Figure 12: Flipped-Classroom Prototype: Teaching-Learning Cycle (Phase 3) 69
Figure 13: Flipped-Classroom Prototype: Teaching-Learning Cycle (Phase 4) 69
Figure 14: Data Triangulation (Points of Data Collection) 71
Figure 15: Inductive Category Development 72
Figure 16: Category System of the Qualitative Content Analysis 73
Figure 17: Model of the Research Research Assumptions for PL-RPA 99
Figure 18: Guiding Idea for Peer-Learning Reference Processes 100
Figure 19: Peer-Learning Reference-Process Approach 101
Figure 20: Design Science Cycles 108
Figure 21: Working Definition of Knowledge Transfer 116
Figure 22: FPM of the Peer-Learning Process Design 120
Figure 23: Validating the PL-PD: Iterative Development and Data Basis 126
Figure 24: Procedures of the Walkthrough 128
Figure 25: Procedures of the Pilot Scheme 129
Figure 26: Category System and Coding 131
Figure 27: DSR Three-Cycle View in the Context of the Study 141
Figure 28: Treatments in the Pilot Schemes 156
Figure 29: Procedures of the Online Quasi Experiments 202
Figure 30: Overview of Measures 205

Figure 31: Research Agenda 241

List of Tables

Table 1: Publications that Form the Basis of the Thesis 16
Table 2: Learning Theories: Behaviorism, Cognitivism, Constructivism............... 18
Table 3: Definition of Key Concepts of Collaboration Engineering....................... 26
Table 4: Roles in Collaboration Engineering 27
Table 5: Structure of an Internal Agenda 32
Table 6: Indicators to Measure the Quality of a Collaborative Work Practice 33
Table 7: Paradigms of Scientific Epistemology 35
Table 8: Taxonomy of Theory in Design Science Research 39
Table 9: Descriptive Knowledge vs. Prescriptive Knowledge 40
Table 10: Design Science Research Contributions 40
Table 11: Design Science Research Knowledge Contribution Framework 41
Table 12: Overview of Methods for Creating and Evaluating Design Artifacts 42
Table 13: Overview of Validation Methods in Collaboration Engineering 43
Table 14: Flipped-Classroom-Concept and its Knowledge Contributions............. 47
Table 15: Flipped-Classroom Concept vs. Traditional Large-Scale Lectures........ 50
Table 16: Generalizable Requirements from Theory of Interaction....................... 53
Table 17: Design Principles for a Flipped-Classroom Concept 56
Table 18: Teaching-Learning Cycle – Phase 1: Self-Learning (Online)................ 60
Table 19: Teaching-Learning Cycle – Phase 2: Peer Learning (Online)................ 62
Table 20: Teaching-Learning Cycle – Phase 3: Transfer (Presence) 63
Table 21: Teaching-Learning Cycle – Phase 4: Application (Presence)................ 64
Table 22: Flipped-Classroom Prototype vs. Original Course Format 66
Table 23: Flipped-Classroom Prototype (Phase 2): Characteristics 68
Table 24: Data Triangulation (Data Basis) 71
Table 25: Coding Guideline.. 74
Table 26: Content Analysis Results for Category I - Teaching Approach 76
Table 27: Content Analysis Results for Category II - Phase 1: Self-Learning....... 77
Table 28: Content Analysis Results for Category III - Phase 2: Peer Learning 80
Table 29: Content Analysis Results for Category IV - Phase 3: Transfer.............. 81
Table 30: Content Analysis Results for Category V - Phase 4: Application.......... 82

Table 31: Recommendations for Action to Use the Flipped-Classroom Concept.. 87
Table 32: The Flipped-Classroom Concept in a Nutshell...................................... 89
Table 33: Classification of Peer Learning Concepts 96
Table 34: Collaboration Engineering in the Context of the PL-PD...................... 112
Table 35: Generalizable Requirements for Enhancing Knowledge Transfer....... 118
Table 36: Internal Agenda of the Peer-Learning Process Design......................... 125
Table 37: Semi-structured Questions during the Walkthrough 128
Table 38: Measures of the Pre- and Post-Evaluation... 130
Table 39: Qualitative Content Analysis – Coding Guideline 131
Table 40: Results for Satisfaction with PL-PD.. 132
Table 41: Descriptive Statistics for Knowledge Measures................................... 133
Table 42: Generalizable Requirements for Empowering Lecturers to Enhance PL.. 147
Table 43: General Conditions to Build an Exemplary Instance of PL-PA........... 148
Table 44: Problem-Solving Pattern (PSP): Overview and Moderation Plan........ 151
Table 45: Critical Thinking Pattern (CTP): Overview and Moderation Plan....... 153
Table 46: Mixed-Method Approach to Evaluate the PL-PA 154
Table 47: Requirement-based Evaluation of PL-PA 157
Table 48: Qualitative Content Analysis – Category System and Coding............ 158
Table 49: Hypothesis and Exploratory Research Questions................................ 159
Table 50: Subgroup Structure: Manipulation Check and Knowledge Increases.. 160
Table 51: Evaluation Results: Means, Differences in Satisfaction....................... 161
Table 52: Step 1: Registration – Individual (Asynchronous) 179
Table 53: Step 2: Knowledge Test – Individual (Asynchronous) 180
Table 54: Step 3: Brainstorming – Subgroups (Synchronous) 183
Table 55: Step 4: Converging – Breakout Groups (Synchronous) 185
Table 56: Step 5: Reporting – Breakout Groups (Synchronous).......................... 187
Table 57: Overview of the HLL Process 188
Table 58: HLL-PSA - Step 1: Registration – Individual (Asynchronous) 194
Table 59: HLL-PSA - Step 2: Knowledge Test – Individual (Asynchronous)..... 195
Table 60: HLL-PSA - Step 3: Brainstorming – Subgroups (Asynchronous)....... 196
Table 61: HLL-PSA - Step 4: Converging – Breakout groups (Synchronous).... 197

Table 62: HLL-PSA - Step 5: Reporting – Breakout Groups (Synchronous) 198
Table 63: Requirement-Based Evaluation 200
Table 64: Differences between Treatment and Control Sample 204
Table 65: Actual LLL and HLL by Group Deliverable Lecturer Assessment 206
Table 66: Satisfaction Measures 208
Table 67: LLL Pre-Test Performance by Treatment 210
Table 68: Differences in HLL by Treatment 211
Table 69: Overall Effects on LLL 212
Table 70: Differences in LLL by Treatment 213
Table 71: Differences in Satisfaction by Treatment 214
Table 72: Overview of the Results for Analyzing Effects of LLL and HLL 215
Table 73: Knowledge Contributions in the Context of the HLL Design Theory . 220
Table 74: Overview of the Limitations in the Studies 227

List of Abbreviations

CE	Collaboration Engineering
CoPDA	Collaboration Process Design Approach
CSCL	Computer Supported Cooperative Learning
D	Design Principle
DG	Design Goal
DSR	Design Science Research
FPM	Facilitation Process Model
GR	Generalizable Requirements
GSS	Group Support System
HLL	Higher-Level Learning
HLL-PSA	Higher-Level Learning Process-Support-Application
LLL	Lower-Level Learning
LM	Learning Material
LMS	Learning Management System
MOOC	Massive Open Online Course
PA	Peer Assessment
PC	Peer Creation
PL	Peer Learning
PL-PA	Peer-Learning Pattern Approach
PL-PD	Peer-Learning Process Design
PL-RPA	Peer-Learning Reference-Process Approach

PR	Peer Review
PSA	Process Support Application
RQ	Research Question
SA	Self-Assessment
SPOC	Small Private Online Courses

1 INTRODUCTION

1.1 Problem Statement

„I cannot teach anybody anything.
I can only make them think"
(Socrates)

With increasing availability of information – anytime, anyplace – factual knowledge becomes plentiful and inexpensive. Performance of today's knowledge workers depends more heavily on the degree to which they have mastered higher-level thinking skills such as critical thinking, problem-solving, communication, and cooperation (David/Foray 2003; García-Aracil/Van der Velden 2008; Johnson et al. 2015). In order to prepare the knowledge workers at an early stage for these demands, universities and educational organizations have to provide high-quality education that copes with these demands.

First, it is important to understand the foundations that are necessary to master those skills. This leads to constructivist driven learning paradigms and highler-level learning (HLL). HLL refers to the upper levels of Bloom's revised taxonomy of educational objectives (Krathwohl 2002). At the higher levels, learners can critique information and arguments, can construct and defend a position, and can reason beyond available information to produce original intellective work. Lower-level learning (LLL) refers to the lower levels of Bloom's revised taxonomy of educational objectives (Krathwohl 2002). At the lower levels, learners can recall facts and basic concepts, and can recognize, identify, and explain ideas and concepts. LLL can be attained by memorizing facts and concepts. To build higher-level knowledge chunks, however, learners need, for example, to develop a position, offer it to others for challenge, and defend their positions (Vygotsky 1978). Learners experience their environment and experience ad-hoc interaction with others (e.g. learners and/ or instructors). Consequently, collaboration is needed to achieve those learning effects. Collaboration describes the work of two or more people on common material, which is characterized by coordination, communication, and cooperation (Leimeister 2014).

Second, it is important to understand the situation that e.g. universities face. Universities face increasing financial pressure and increasing class sizes (Moore 2002b). In the USA for example, state funding per full-time equivalent (FTE) student in public institutions declined from $10,110 in the years 2000–01 to $ 7,540 in the years 2014–15. In parallel, there was an increase of 16% in enrollment numbers from fall 2003 to fall 2013 (Ma et al. 2015). As a consequence, university class sizes grow larger (Ma et al. 2015). This, however, has a negative effect on learners' performance (Kokkelenberg/Dillon/Christy 2008). Learners have fewer opportunities to explain their understanding and receive feedback, or to reinforce or challenge their understandings.

Therefore, the challenge is to cope with these conflicting demands. On the one hand, close collaboration is needed to achieve HLL effects and on the other hand due to large class sizes traditional teaching-learning concepts are still a common default at universities. Therefore, it is important to have approaches that help to enhance collaboration in order to enable HLL in large classes. In this context, different approaches seem to be suitable. A solution might be to ask the learners to challenge or reinforce one another's higher-level knowledge positions based on their current understandings (Webb 2010). In this context, peer learning (PL) literature offers some promising approaches to foster the reciprocal exchanges of understanding and feedback (Topping 2005). For example, the top learners can help the bottom learners to better understand the concepts of domain knowledge, which would be likely to increase the levels of understanding for both. Learners benefit from gaining new domain knowledge as well as improving their soft skills (e.g., communication, teamwork, positive reinforcement). However, PL works best in small groups and is not well suited to large class sizes since collaboration becomes difficult as group size increases beyond six (Ingham et al. 1974). In addition, PL activities are less predictive and therefore demand inventing ad hoc collaboration between the learners and the instructor as well as pedagogical expertise and moderation from the lecturer. Even if PL seems to be a promising approach, this would only be practical in small classes and with the guidance of an instructor.

Nevertheless there is literature that tries to make PL activities conductive and predictive for large class sizes. This literature tries to enable learner interactions in large class sizes by providing IT-supported tools. The use of IT-tools allows to divide a large class of learners into smaller groups for PL activities. However, many of those PL approaches in current literature – e.g., Computer Supported Collaborative Learning (CSCL) Scripts (Dillenbourg 2002; Kollar/Fischer/Hesse 2006) – tend to focus on acquisition of lower-level domain knowledge (Kollar/Fischer/Hesse 2006). Few support HLL, and those that do support HLL tend not to be practical for large classes since they are complex and less reusable. Therefore, even in those IT-supported PL settings, learners may still struggle to achieve higher-levels of domain knowledge. The PL challenge may be exacerbated by some learning literature which posits that collaborative learner interactions should not be prescribed; they should be emergent and ad hoc so as not to stifle student learning (Bodner 1986; Poplin 1988; Jones/Brader-Araje 2002). These papers prescribe that instructors should not impose a process on students (Dillenbourg 2002).

Even if there is a huge amount of valuable research in the context of CSCL literature that focuses on collaborative working spaces or CSCL environments (Haake/Schwabe/Wessner 2012) as well as learning literature that posits that learner interactions should not be prescribed (Bodner 1986; Poplin 1988; Jones/Brader-Araje 2002), there is still an important pitfall remaining (Kreijns/Kirschner/Jochems 2003). When considering CSCL environments, one cannot take it for granted that social interactions will automatically occur (Kreijns/Kirschner/Jochems 2003). Therefore, social interactions need to be designed in a way to stimulate and guide the collaboration among learners toward a meaningful manner (Kreijns/Kirschner/Jochems 2003). Interestingly, there is a body of collaboration literature that supports that point of view. Beyond a certain point, lacking guidance from an expert instructor, learners may begin to pool their ignorance instead of building higher-level knowledge chunks. Under some conditions process restrictions can help learners focus on the task and not becoming distracted by other things (Briggs et al. 2013). Therefore, collaboration literature argues that most individuals do not have an intuitive grasp of how to collaborate effectively, so, left to themselves, most groups tend to be ineffective (Briggs et al. 2013). In this context, collaboration engineering (CE) provides an approach to designing collaborative work practices for high-value tasks and transferring them to practitioners to execute for themselves without ongoing support from an expert facilitator (Briggs/de Vreede/Nunamaker 2003). Rather than impeding group performance, process restrictions can – under certain conditions – increase the number, quality, and creativity of ideas a group creates, increase the number of communication cues exchanges within a group, and improve the quality of its work products while reducing cognitive load (Dennis/Nunamaker Jr/Vogel 1990; Fjermestad/Hiltz 1998; Jerry Fjermestad 2000; Briggs et al. 2013).

Consequently, it is important to understand that there are two lines of thinking - cognitive mechanisms of learning conflate with functional mechanisms of collaboration. Learning mechanisms require experiences that give rise to more sophisticated knowledge frames[1] while functional mechanisms of collaboration require experiences,

[1] *Frames* bundle concepts – an easy example is a picnic frame that might bundle concepts of food, eating, outdoors – that are connected into a network with other concepts.

that give rise to more structure of activities and facilitation guidance. In the context of the above described situation, IT-suppored collaborative reference processes seem to be an appropriate solution to fostering communication, reasoning, and information access. Those processes will have the potential to encourage learners in enjoyable learning activities that foster HLL, while restricting them from activities that would interfere with their collaboration and block their progress toward HLL. This leads to the general research assumption of this thesis, that using CE as a design methdolology can support developing IT-supported reference processes that have the potential to structure collaboration among learners in large class sizes in a way that helps them to achieve higher levels of knowledge.

To cope with the above described situation and to verify whether the research assumption constitutes an appropriate solution, three central challenges occur:

Challenge 1: Explore the application domain of peer learning and create conditions to support higher-level-learning in large classes.

To design and implement HLL approaches that are suitable for large-class sizes an understanding of the application domain is necessary. On the one hand, it is important to understand the mechanisms and potentials of PL. On the other hand, it is important to understand the conditions of large class sizes and to create teaching-learning concepts that support PL activities. This leads to the challenge of designing a teaching-learning concept for large-class sizes that opens space for PL activities and copes with the demands outlined above.

Challenge 2: Develop an approach to systematically design reusable peer learning activities, that copes with the demands from learning and collaboration literatures.

Having a teaching-learning concept that comprises the conditions to implement and enable PL activities builds the necessary basis. However, to make PL activities manageable for lecturers, it is important that lecturers can replicate PL activities with predictive results with regard to learner activities. Thus, reference processes for PL might be a solution. CE provides an approach to develop such reference processes for PL activities. However, as described above less is known on how to systematically design PL activities for HLL. This leads to the challenge of bridging the research domains of PL and CE. The challenge is to develop an approach to systematically design reference processes for PL which copes with the demands from learning literature and at the same time packages collaboration expertise in a way that instructors can execute a well-designed work practice of PL activities without training in tools and techniques. Thus, an approach is required that describes the conceptual foundations of designing PL activities.

Challenge 3: Explore the proof of value of reference processes for peer learning in the field.

Having an approach to design reference processes for peer learning, however, will not provide insights for a proof of value. Proof of value research is needed to demonstrate that a solution such as reference processes for peer learning can be useful to cope with problems in the field (Nunamaker Jr et al. 2015). To demonstrate the potentials of reference process for PL and to show its effectiveness, several reference processes need to be developed and evaluated in the field. This leads to the challenge to design and to validate reference processes for PL to explore effects of increases in learner's knowledge base.

1.2 Solution Statement and Research Questions

The thesis contributes to the body of knowledge of PL and CE literature by helping to overcome the three challenges described in section 1.1. Against that background, the overall design goals of the thesis can be described as follows:

Design Goal (I): Understand the relevance of systematically designing PL activities and create necessary conditions for PL in the application domain of universities.

Design Goal (II): Develop an approach that creates an understanding of how to systematically design PL activities to enhance learning effects in a replicable and transferable manner.

Design Goal (III): Design, implement and evaluate reference processes for PL as a proof of value that provide insights on whether systematically designed PL activities among learners are replicable and transferable, and whether they enhance learning effects.

In this context, a *reference process for PL* describes a predictive and transferable design of a sequence of PL activities that aim to solve a recurring problem. The design is

a) *predictive* if the same design of a reference process can be executed for several times and with different groups of learners and produces comparable or same results when it comes to learner satisfaction, knowledge increases;

b) *transferable* if the execution of the same design of a reference process is independent from tool support, facilitator and class size and produces comparable or the same results when it comes to learner satisfaction, knowledge increases. Consequently, transferability will be given by conducting the same design

- with *different tool support* [paper-based tools vs. IT-supported tools];
- by *different lecturers* that facilitate the PL activities;
- in *large classes* with automated IT support.

To achieve the design goals, I will derive and answer three *research questions* (RQ). In the following I describe the RQ. For each RQ I will summarize the RQ; illustrate which of the before described challenge will be addressed; define the design artifact that I will develop to answer the question and; specify the method that I used to investigate findings.

Typically, traditional large classes focus on factual knowledge and are characterized by a low level of learner-learner and learner-lecturer interaction. Large classes often provide only very restricted spaces in order to e.g. discuss learning content. Consequently, they are less suitable to train learning content respective domain knowledge on the upper levels of Bloom's revised taxonomy (see section 2.1.3). However, interactions like discussions among learners are important to *apply, analyze, evaluate* and *create* knowledge and thus to achieve *higher-level learning (HLL)* effects on the upper levels of Bloom's revised taxonomy. PL has the potential to boost HLL effects. Enhancing HLL requires an understanding of PL mechanisms and its conditions. In particular a teaching-learning concept is needed that provides conditions for leveraging the power of PL in large classes. This leads to RQ 1.

RQ1	**What are basic conditions for a teaching-learning concept that provides opportunities to leverage the power of peer learning in large classes? *(Application domain)***
Relation to	*Challenge 1:* Explore the application domain of peer learning and create conditions to support higher-level-learning in large classes.
Design artifact	*Flipped-Classroom Concept* – a teaching-learning concept that describes the application domain and creates conditions for PL.
Methods	Design science research – theory-driven design, semi-structured interviews, online survey, content analysis.

To answer RQ 1, I analyze and create conditions which activate learners, implement PL activities in large classes that allow discussions among learners in small groups, and deal with demands from constructivist learning theory. Following PL from a constructivist point of view, learners need to experience their environment and to interact with other learners or with the lecturer to achieve learning effects and thus, to expand their expertise. Learners should be free in their experience and should only receive few or no guidance at all. RQ 1 already provides insights into the basic conditions necessary to implement PL in large classes. The results show the *set of unsolved problems* that arise when *leveraging the power of PL in large classes by making use of systematically designed PL activities*. PL requires ad hoc collaboration such as discussions and feedback. The integration of such collaboration into the classroom is a complex task and learner outcomes cannot be predicted. Learners often are overstrained when assignments are complex and open-ended and struggle to coordinate their learning experience in small groups on their own. As a consequence, their motivation decreases, and they often do not engage in these HLL experiences. Most individuals, learners and lecturers alike, do not have an intuitive grasp of effective collaboration. Packaging collaboration expertise to provide guidance can serve as a starting point for leveraging PL effects in large classes. Thus, systematically designing PL activities that package sufficient collaboration expertise offers a solution. This requires a sophisticated understanding of PL and CE as a methodology to systematically design PL activities. It is vital that the designed PL activities guide learners so that they on the one hand can focus on learning assignments and on the other hand have the freedom to experience their environment. This leads to RQ 2:

RQ2	**What are conceptual foundations and assumptions to systematically design reference processes for peer learning? *(Conceptual foundations)***
Relation to	*Challenge 2:* Develop an approach to systematically design reusable peer learning activities, that copes with the demands from learning and collaboration literatures.
Design artifact	*Peer-Learning Reference-Process Approach (PL-RPA)* – an approach to clarify the conceptual foundations to systematically design PL activities.
Methods	Theory-driven design.

RQ 2 aims at providing insights into the set of unsolved problems inherent in systematically designing PL activities. To solve these problems, a reusable design of PL activities is needed that is suitable for large classes. To answer RQ 2, I explore basic research assumptions and draw from existing theories to systematically design PL activities. I develop an approach to design PL reference processes, the Peer-Learning Reference-Process Approach (PL-RPA). The PL-RPA provides important insights. It combines kernel theories of PL that provide pedagogical guidance and of CE that provide a design methodology to develop reference processes for PL. Although the PL-RPA illustrates the conceptual foundations to systematically design PL activities, a proof of value is needed to gain insights and explore whether systematically designed PL activities are predictive and transferable, and whether they produce learning effects for LLL and HLL among learners. This leads to RQ 3:

RQ3	What are characteristics and effects of peer-learning reference processes? (Design, implementation, evaluation)
Relation to	*Challenge 3: Explore the proof of value of reference processes for peer learning in the field.*
Design artifact	*Several reference processes for PL* – each establishing a process design as a generalizable solution, an according expository instantiation and evaluation of the effects while conducting the design in the field with real stakeholders.
RQ3a	What are characteristics and effects of a peer-learning reference process for transfer and documentation of knowledge that can be used regardless of tool-support and that helps learners to expand their knowledge base?
Design artifact	*Peer-Learning Process Design (PL-PD)* – a reference process for knowledge documentation and transfer
Methods	Design science research – theory-driven design, simulation, walkthrough, observation, pilot scheme.
RQ3b	How can peer-learning knowledge be packaged in a reusable design so that it comprises sufficient collaboration techniques to empower lecturers (and learners) to conduct (and follow) HLL activities in the classroom?
Design artifact	*Peer-Learning Pattern Approach (PL-PA)* – a reference process that modularizes two small reference processes necessary for problem-solving and critical thinking.
Methods	Design science research – theory-driven design, simulation, walkthrough, observation, pilot scheme.
RQ3c	How can one enhance higher-level learning in large classes among students?
Design artifact	*HLL Design Theory* – a HLL Reference Process that describes the design for enhancing PL activities to solve complex case-study assignments in order to achieve HLL effects; a HLL Methodology that describes how to design an IT-supported HLL Process Support Application (PSA) from the HLL reference process; an exemplar instance in the form of the HLL-PSA.
Methods	Design science research – theory-driven design, online quasi experiment

To answer RQ 3 I use a Design Science Research (DSR) approach to develop three reference processes for PL and describe for each reference process the design, implementation, and evaluation. To achieve a first proof of value and to gain insights into the question whether PL activities can be designed in a systematic way and lead to predictive results in learner satisfaction and outcomes, I develop the first reference process – the *Peer-Learning Process Design (PL-PD)* for transfer and documentation of knowledge among learners to answer RQ 3a. I focus on collaborative knowledge documentation since knowledge documentations (e.g., textual explanations, visualization, or video) represent knowledge concepts and their connections. It requires a deep and sophisticated understanding to document knowledge and to enhance PL effects for HLL. When it comes to developing transferable reference processes for PL, IT-tool support provides potentials for transferability. However, first it is important to analyze whether PL activities can be systematically designed to evoke predictive results and second to analyze its transferability. Therefor I use the PL-PD with paper-based and IT-supported tools and test whether they lead to comparable results. The tests show that PL activities can systematically be designed and evoke comparable results among learners. This leads to the next step.

To complete the whole process of PL-PD a certain amount of time is necessary. However, a class typically lasts only approx. 2 hours. Therefore, it is necessary to modularize the first reference process and to analyze its transferability with respect to conducting the same design by different lecturers. Because of that it is important to analyze if there are smaller building blocks within PL-PD for specific learning activities. It is also important to analyze whether the design of reference processes for PL empowers lecturers to conduct PL activities in the classroom. This leads me to RQ 3b that develops the *second reference process, the Peer-Learning Pattern Approach (PL-PA)*. The PL-PA comprises two small building blocks aimed at problem-solving and critical thinking. The results show that different lecturers are able to conduct the process design and to provoke comparable results among learners.

Based on these results it was possible to design and implement a reference process in a large-class setting to analyze HLL effects. This leads to RQ 3c. I use the problem-solving pattern from the PL-PA and refine the design of the reference process by adding pre- and post-activities that are necessary to create groups with less- and high-experienced learners. This leads to the *third reference process, the HLL Design Theory)*. To answer the RQ with respect to HLL effects I conducted an online quasi experiment with a treatment group and a control group. Results show that there is a significant increase in HLL among learners who followed the structured collaboration with the reference process from the HLL Design Theory in the treatment group compared to those learners who followed the unstructured collaboration in the control group.

1.3 Structure of the Thesis

1.3.1 Thesis Outline and Summary of Chapters

To achieve the design goals and to answer the RQs that I described in section 1.2, the thesis is structured as follows (see Figure 1).

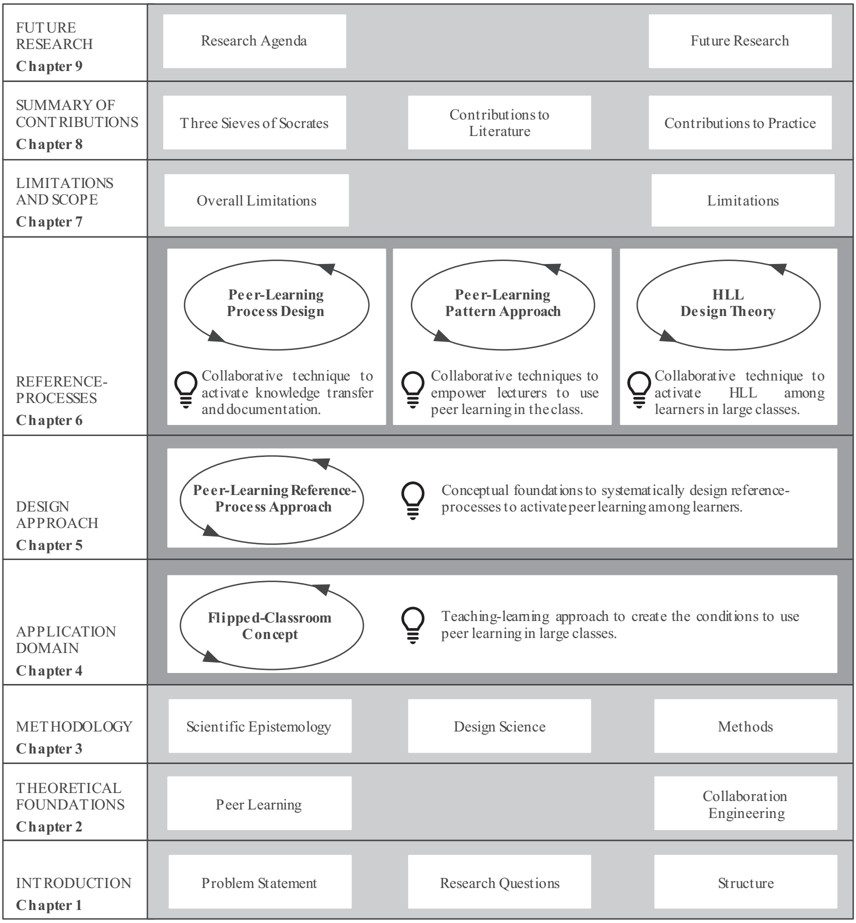


Figure 1: **Structure of the Thesis**
Source: own illustration

The *chapters 1-3* create the conceptual, theoretical and methodological basis of the thesis. They describe the foundations of my research. *Chapters 4-6* describe my research activities in the context of five distinct studies. These studies are intertwined with the at the beginning illustrated challenges and provide answers for the RQs. Consequently, these studies constitute the core of the thesis. *Chapters 7-9* summarize the conclusion of the investigated findings in terms of limitations, knowledge contributions and future research.

C*hapter 1* describes the topic and overall design goals of the thesis and its relevance for the scientific community and for practice. It poses three research questions to achieve the overall design goals.

Chapter 2 describes the conceptual and theoretical framework of the thesis and the kernel theories and related work on which the research grounds. To inform the design choices for designing reference processes for PL with pedagogical guidance, the chapter describes the pedagogical foundations of Peer Learning (PL) with respect to related work and characteristics (see section 2.1). It proposes a working definition of the construct expertise as an indicator to measure PL quality in terms of knowledge increases among learners. Collaboration Engineering (CE) serves as the design methodology to package sufficient collaboration expertise into reference processes for PL and to develop reference processes for PL activities to enhance HLL (see section 2.2). Therefore, the chapter refers to the aims of CE, the roles of CE, the Six-Layer Model of Collaboration as a design methodology and guidelines to document collaborative process designs. Finally, the chapter proposes indicators to measure collaboration process quality.

Chapter 3 considers methodological underpinnings of the research and reflects current research decisions in relation to insights from scientific epistemology. The chapter gives a brief overview of epistemological paradigms and how they become addressed in this thesis. Moreover, the chapter describes *Design Science Research (DSR)* as the overall research approach and discusses the underlying research decisions of the thesis amongst the DSR background. In that context, the chapter describes the understanding of theory in DSR, the classification and the framing of design knowledge and refers to established contribution types in DSR.

The *chapters 4–6* describe in total five different studies. Systematically designing structured PL activities by using insights from CE research constitutes a new field of research and therefore demands a gradual and explorative research process. Therefore, the several studies are in relation with each other. The results from the studies justify the demand for moving forward in my explorative research process and to investigate deeper findings toward leveraging the potentials of PL. Since this constitutes a search process in a new field, e.g. the first study focuses on the application domain and its conditions as the justificatory basis for the research in that field. From a methodological perspective, each study describes a DSR initiative toward the current RQ. To report a DSR iniative, my studies follow formal aspects of DSR and more precisely the three-cycle view of DSR (see section 3.2.1). In each DSR project the environment and the knowledge base need to be respected. Those provide the fundamentals for the relevance and rigor cycle. To report the DSR iniatives I focus in each study on the environment and the knowledge base to inform my design choices in order to complete a design and evaluate cycle. Therefore, a brief problem statement and theoretical foundations of the knowledge base are part of each chapter in order to avoid flaws in the logical structure of the DSR initiatives.

The focus of *chapter 4* is on developing a *Flipped-Classroom Concept*, a teaching-learning concept that helps to activate the learner (→ RQ 1). The design goals of the chapter are DG 1 - develop a Flipped-Classroom Concept for large classes to overcome the lack of interaction; and DG 2 - create conditions for PL. The chapter presents requirements that form the necessary conditions to enhance the three interaction types (learner-content, learner-learner, and learner-lecturer interaction) and to design principles for PL to develop a flipped classroom. The chapter draws from a theory-informed design of the *Flipped-Classroom Concept as* a generalizable solution and describes an expository instance of implementing the Flipped-Classroom Concept in a large class. The concept helps to understand and to create the conditions for applying PL in large classes. Even though the concept provides the necessary conditions to implement PL, the results of the evaluation inter alia show that it fails to leverage the power of PL activities. Learners seem to feel overstrained and refuse to engage in PL activities with other learners. This shows a set of unsolved problems that needs to be analyzed by packaging collaboration expertise with the aim of providing facilitation guidance on PL activities.

Chapter 5 develops the *Peer-Learning Reference-Process Approach (PL-RPA)* (→ RQ 2). The design goal of the chapter is DG 1 - develop an approach that creates an understanding to systematically design PL activities to enhance learning effects in a replicable and transferable manner. To create an understanding of how to systematically design PL activities for HLL the chapter reflects basics from PL as a pedagogical underpinning and CE as a design methodology. Those constitute the foundations for the guiding idea and research assumptions to systematically design PL activities. Theory-driven requirements from PL and CE inform the PL-RPA. The PL-RPA creates an understanding of how to respect specific dimensions of PL requirements to ensure pedagogical guidance. Furthermore, the approach helps to understand how to split structure in PL activities and how to sequence a complex open-ended learning assignment into subtasks.

Chapter 6.1 describes a first reference process for PL, the *Peer-Learning Process Design (PL-PD),* for enhancing knowledge documentation and transfer among learners (→ RQ 3a). The design goals of the chapter are DG 1 - to leverage the power of collaborative knowledge transfer; and DG 2 - to package sufficient collaboration expertise in the design of the PL-PD so that it can be executed with and without IT tool support. The chapter outlines theory-driven requirements for knowledge transfer and documentation with regard to pedagogical guidance of PL, explains the use of CE as a design methodology and distills a generalizable solution of PL-PD. The chapter describes a short outline of PL-PD implementations with paper-based and IT-supported tools to explain the evaluation context which consists of simulation, walkthrough and pilot schemes for PL-PD in the field. The evaluation of PL-PD serves as a first proof of value of systematically designing PL activities. The chapter closes with a discussion of first results with regard to learner satisfaction, LLL effects, and differences of conducting PL-PD with paper-based and IT-supported tools.

Chapter 6.2 describes the second reference process for PL, the *Peer-Learning Pattern Approach (PL-PA)* (→ RQ 3b). The design goals of the chapter are DG 1 - to help lecturers enhance PL activities for HLL in the areas of problem-solving and critical thinking in classes in a predictive way; and DG 2 - to help learners proceed through PL activities with assisting guidance on collaboration. The chapter illustrates a modular point of view of reference processes for PL in the form of patterns for stimulating specific learning activities – a pattern for problem-solving and a pattern for critical thinking. The chapter describes theory-driven requirements that bring about these patterns. The chapter shows that the patterns can be used on their own or can be combined with each other. The documentation of each pattern has the potential to empower lectures to conduct specific PL activities in the classroom. Having said this, the evaluation described in that chapter illustrates a pilot scheme in which lecturers conducted the reference process for PL in the classroom. The results illustrated in this chapter show that different lecturers can conduct PL-PA and achieve comparable results of learner satisfaction and that learners are able to follow complex HLL activities.

Chapter 6.3 describes the third reference process for PL that is inherent in the *HLL Design Theory* → RQ 3c). The design goals of the chapter are DG 1 - to enhance HLL for large class contexts; and DG 2 - to package sufficient collaboration expertise in the process design so that non-experts (learners) can execute a well-designed work practice without training in tools or techniques. The chapter derives generalizable requirements for enhancing HLL in large classes, illustrates a detailed description of the HLL Reference Process as generalizable solution and its expository instantiation in the form of the HLL-PSA that I lustrate by a description of the Moodle-Prototype (large-class implementation) as well as the HLL Methdolology that provides guidance on how to build an expository instantation from the HLL Reference Process. To investigate a possible increase in learning success on the upper levels illustrates for the evaluation a quasi-experiment in a large class with undergraduate information systems Bachelor students. The experimental design outlines a treatment group (learners who followed the HLL reference process [systematically designed PL activities]) and a control group (learners who were free in their PL activities). The results in this chapter show that the HLL knowledge increases in the treatment group are higher than in the control group.

Chapter 7 summarizes and discusses the limitations of the thesis with respect to the several studies. *Chapter 8* provides a summary and discussion of the knowledge contributions. Based on this, *chapter 9* closes with an outlook on future research.

1.3.2 Chapters in Relation to Research Questions and Publications

Each of the *chapters 4–6* describes the development and evaluation of one design artifact and answers one of my RQs. This way, researchers as well as practitioners can use each of the chapters to build their own instantiations for the defined purposes. Table 1 illustrates my publications that have addressed chapters in parts or entirely. At the beginning of each chapter I will refer to the publication that significantly influenced the content of the chapter.

No.	Previous Publication	Rating		RQ	Chap-ter
		JQ 3[2]	WK WI[3]		
1	**Oeste, S.; Lehmann, K.; Janson, A.; Leimeister, J. M. (2014):** Flipping the Is Classroom – Theory-Driven Design for Large-Scale Lectures. 35th International Conference on Information Systems (ICIS), Auckland, New Zealand 2014.	(A)	(A)	1	4
2	**Oeste, S.; Lehmann, K.; Janson, A.; Söllner, M.; Leimeister, J. M. (2015b):** Redesigning University Large Scale Lectures: How to Activate the Learner. Academy of Management Annual Meeting (AOM), Vancouver, BC, Canada 2015b.	(B)	(-)		
3	**Lehmann, K.; Oeste, S.; Janson, A.; Söllner, M.; Leimeister, J. M. (2015):** Flipping the Classroom – It-Unterstützte Lerneraktivierung Zur Verbesserung Des Lernerfolges Einer Universitären Massenlehrveranstaltung. In: HMD Praxis der Wirtschaftsinformatik, Vol. 52 (2015) Nr. 1, S. 81-95.	(D)	(B)		
4	**Oeste, S.; Söllner, M.; Leimeister, J. M. (2014):** Engineering Peer-to-Peer Learning Processes for Generating High Quality Learning Materials. 20th International Conference on Collaboration and Technology (CRIWG), Santiago, Chile 2014.	(C)	(-)	2	5
5	**Oeste-Reiß, S.; Söllner, M.; Leimeister, J. M. (2016):** Development of a Peer-Creation-Process to Leverage the Power of Collaborative Knowledge Transfer. Hawaiian International Conference on System Sciences (HICSS), Kauai, Hawaii, USA. 2016.	(C)	(B)	3a	6.1
6	**Oeste, S.; Bittner, E. A. C.; Söllner, M.; Leimeister, J. M. (2015a):** How to Empower Lecturers to Leverage the Benefits of Peer Learning: Theory-Driven Design of Collaborative Learning Patterns. Annual Meeting of the Academy of Management (AoM Meeting) - PDW 'Management Education and Learning Writers Workshop', Vancouver, BC, Canada 2015a.	(B)	(-)	3b	6.2
7	**Oeste-Reiß, S.; Bittner, E. A. C.; Söllner, M. (2017):** Yes You Can – Empowering Lecturers to Simulate Collaboration among Learners in the Disciplines of Problem-Solving and Critical Thinking Regardless of Class Size. Internationale Tagung Wirtschaftsinformatik (WI), St.Gallen, Schweiz 2017.	(C)	(A)		
8	**Oeste-Reiß, S.; Briggs, R. O.; Söllner, M.; Leimeister, J. M. (submit to):** Towards a Design Theory for Enhancing Higher-level learning in Large University Classes with Collaborative Learning Experiences. In: Journal of Management Information Systems (JMIS), (submit to).	(A)	(A)	3c	6.3

Table 1: **Publications that Form the Basis of the Thesis**
Source: own illustration

[2] JourQual 3 Rating of the German Academic Association for Business Research (VHB), 2015.
[3] WI Orientation List of the section Business Information Systems (WKWI) of the German Academic Association for Business Research (VHB), February 27, 2008.

2 THEORETICAL FOUNDATIONS

2.1 Pedagogical Foundations of Peer Learning

When designing reference processes for PL it is important to support learners in their learning experiences and to actively involve them in learning activities with others. For that reason, an understanding of the basic mechanisms of PL is needed. Therefore, I will refer to existing learning theories in the following subsections and explain why I base my research on constructivist learning paradigms. I will also give a brief description on the foundations and related concepts of PL. Moreover, I will provide a description of the construct ‘expertise’ which serves as a phenomenon of interest of my research and I will outline a working definition of this construct.

2.1.1 Constructivist Learning Theory

Comparison of Learning Theories

In pedagogical practice several learning theories exist (see Table 2). Besides the constructivist learning paradigm there are behaviorism and cognitivism. When comparing the constructivist paradigm with the others, it becomes apparent that there seems to be high learner centricity and potentials for learner activiation in the context of the constructivistic learning paradigm. Constructivist learning settings give learners the chance to gain most sophisticated understanding of knowledge concepts. The active interaction of learners with their environment helps them to build shared mental models and achieve HLL effects. Moreover, this paradigm seems, besides its positive effects for HLL, to be the most autonomous. In order to develop approaches for enhancing HLL in the digital age and to help learners achieve higher-level thinking skills, such as critical thinking, problem-solving, communication, and cooperation, the constructivist paradigm seems to be the most appropriate one to meet these demands. For that reason, my research in this thesis is based on constructivist learning paradigms.

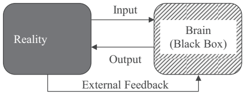
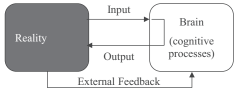
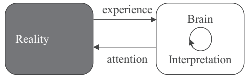
	Behaviorism	Cognitivism	Constructivism
			
Aim	Correct answers	Correct methods to find a solution	Cope with complex problem situations
Paradigm	Stimuli-Response	Problem-solving	Construction
Role of lecturer	Teaching and representing an authority	Observing, helping, and representing a tutor	Cooperating and representing a coach
Feedback	External feedback from the lecturer	External feedback from the lecturer	Internal feedback from the learners
Inter-action	Strict	Dynamic	Autonomous
Charac-teristics	Strict procedure	Dynamic procedure	Dynamic procedure

Table 2: Learning Theories: Behaviorism, Cognitivism, Constructivism
Source: based on Jones and Brader-Araje (2002)

Constructivism

In pedagogical practice the constructivist learning paradigm has emerged as one of the greatest influences (Jones/Brader-Araje 2002). Learners learn from experiencing their environment and constructing their own reality which they compare with their environment. This interplay between their own reality and their environment leads to an internal schematization (Stangl 2006a). A specific form is the social constructivism that primarily focuses on the interplay between the individual learner and other learners (Jones/Brader-Araje 2002). According to the work of Glasersfeld, learning has its roots in social interactions with other learners (Jones/Brader-Araje 2002). Groups of learners construct knowledge by collaboratively creating a shared mental model and a shared understanding. From that point of view, the interaction with other learners and the environment is the central aspect of constructivism. The learner is actively engaged in learning activities by experiencing their environment (Jones/Brader-Araje 2002). Consequently, this learning paradigm demands an active process that involves other learners. In pedagogical practice, social constructivism occurs through teaching-learning strategies of collaborative learning or peer learning. Learners collaborate with each other, share their ideas and knowledge, and challenge each other's position (Jones/Brader-Araje 2002).

2.1.2 Peer Learning and Related Approaches

To underpin the constructivist learning paradigm, so-called experiential learning provides additional guidance (Kolb/Kolb 2005). Experiential learning refers to activities that trigger cognitive mechanisms for learning. Therefore, the subsequent paragraph gives a brief description of experiential learning. In accordance to the constructivist learning paradigm and experiential learning several forms of learning respectively instruction methods emerged over time. Therefore, the following paragraph gives a brief description of instruction methods and introduces the concept of collaborative learning.

Experiential Learning

Experiential learning grounds on six propositions: Learning (1) is a process that engages students in their learning activities; (2) is relearning and refers to drawing on students beliefs to achieve knowledge increases; (3) requires challenging one’s own position; (4) is a holistic process of experiencing the world; (5) results from transactions between the learner and their environment; (6) is a process of creating knowledge through the interplay of a learner with their environment (Kolb/Kolb 2005).

These propositions indicate that experiential learning refers to the construction of knowledge. This construction becomes apparent by means of four learning modes outlined in Kolb’s learning cycle (see Figure 2). Experiences build the basis for observing and reflecting the environment. These become assimilated to abstract concepts, which in turn build new implications for action. These actions trigger further thinking activities and lead to new experiences (Kolb/Kolb 2005).

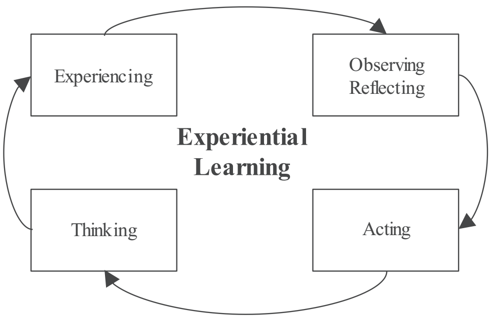


Figure 2: **Kolb’s Learning Cycle**
Source: based on Kolb (1984)

Collaborative Learning and Peer Learning

Collaborative learning describes an instruction method by which learners work in groups and achieve knowledge gains (Gokhale 1995; Dillenbourg 1999). Collaboration stimulates activities among learners that trigger learning mechanis (Dillenbourg 1999). However, it is not a single instruction method. It comprises a multiplicity of instruction methods (Kanev/Kimura/Orr 2009). Typically, lecturers explain learners a learning assignment and crucial elements for their collaboration. They also instruct learners to listen carefully to comments of other learners in their group and to reconsider their judgements and opinions (Gokhale 1995). In that context, learners develop synchronously and interactively a joint solution for a problem (Kanev/Kimura/Orr 2009). Consequently, groupwork and collaboration are critical success factors to enhance collaborative learning (Kanev/Kimura/Orr 2009). This characteristic makes collaborative learning difficult in pedagogical practice since there is only low predictability of learner interactions (Dillenbourg 1999). It is important to understand, that the conditions under which collaboration occur are specified, but there is no guarantee that collaboration will occur (Dillenbourg 1999).

Amongst that background a multitude of instruction methods emerged over time, that set different priorities (see section 5.4.1). The concept of PL often is used synonymus for collaborative learning and underpins the learner centricity. Next to PL related forms are peer creation, peer tutoring and cooperative learning. Those concepts differ in their goal, group formation and task type respectively task structure. Nevertheless, there are three permises in common that are indicative for collaborative learning: First, learning is active and refers to the construction of knowledge (Alavi 1994). Second, social processes occur by which collaboration and teamwork take place (Alavi 1994). Third, activities for problem solving stimulate learning (Alavi 1994). Therefore, collaborative learning has the potential to stimulate HLL, critical thinking and shared understanding (Kreijns/Kirschner/Jochems 2003).

Even if the concept of collaborative learning respectively PL is a promising instruction and learning method, research also shows that strong learners tend to dominate discussions and as a consequence, less experienced and introverted learners tend to withdraw from the collaboration (Gokhale 1995). In addition, another weakness refers to the lack of coordination that impedes group work among learners and, thus, impedes learners in their learning experience (Webb 2010).

Computer Supported Cooperative Learning (CSCL)

To support collaborative learning in a more flexible manner, CSCL emerged. CSCL uses technologies to support learners in their collaborative learning experiences (Kanev/Kimura/Orr 2009; Haake/Schwabe/Wessner 2012). Thus, to create IT-supported learning enmvironments insights from psychological literature, sociological literature, collaborative literature and information systems literature need to be respected (Haake/Schwabe/Wessner 2012). CSCL distinguishes between various forms of IT-supported learning. To distinguish between several forms of IT-supported learning, literature uses various modes of time and place: same time (synchron) and same place; same time (synchron) and different place; different time (asynchron) and same place; different time (asynchron) and different place (Haake/Schwabe/Wessner 2012). The use of technology opens potentials to make collaborative learning applicable to large class sizes.

2.1.3 Bloom's Revised Taxonomy and Higher-Level Learning

In order to specify the term 'higher-level learning', I refer to educational objectives and base my research on the cognitive process dimensions of Bloom's revised learning taxonomy (Krathwohl 2002). Figure 3 illustrates the revised version of this taxonomy.

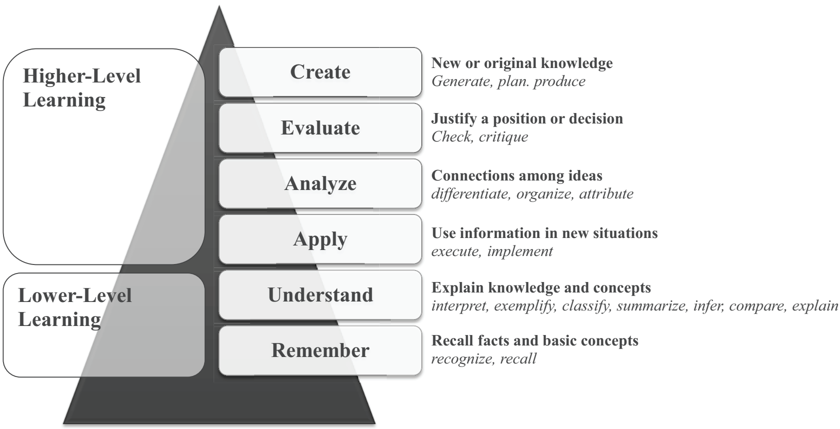


Figure 3: **Cognitive Process Dimensions of Bloom's Revised Taxonomy**
Source: based on Krathwohl (2002) and Armstrong (2016)

The cognitive process dimension '*remember*' at the bottom of Bloom's revised taxonomy refers to retrieving knowledge concepts from long-term memory (Krathwohl 2002). The next dimension, '*understand',* refers to determining the meaning of knowledge concepts that learners receive from messages, or oral, written, and graphic communication (Krathwohl 2002). The third dimension, '*apply',* refers to learning activities in which a learner uses knowledge concepts or a procedure to cope with a given situation (Krathwohl 2002). The fourth dimension, '*analyze',* refers to learning activities in which a learner splits knowledge concepts or learning material into parts and detects how these parts relate to each other and to a holistic structure (Krathwohl 2002). The fifth dimension, '*evaluate',* refers to learning activities in which a learner uses evaluation criteria to make judgements on a given situation or a presented knowledge concept. The sixth dimension, '*create',* refers to learning activities in which a learner creates a novel, coherent whole knowledge concept or an original product by putting together elements from knowledge concepts (Krathwohl 2002).

In the context of the thesis I use the term *higher-level learning (HLL)* to address the upper cognitive process dimensions apply, analyze, evaluate, and create. I refer to *lower-level learning (LLL)* when I refer to the bottom cognitive process dimensions remember and understand.

2.1.4 Expertise as an Indicator of Knowledge Increases

In aiming to analyze HLL, an adequate construct is needed to describe and classify its effects. A construct is a named, rigorously defined abstraction of a phenomenon of interest that gives evidence on how knowledgeable a learner is within a specific knowledge domain. Knowledge is defined as "[…] the fact or condition of being aware of something: the range of one's information or understanding […]" (Dictionary 2016). However, this is not sufficient to analyze knowledge increases because there is neither a reference to the domain of knowledge nor to different levels and amounts of knowledge.

Because of the cognitive mechanisms of the human mind, individuals cannot move directly from ignorance to higher-level understandings; they must proceed in stages. Humans have two classes of memory: long-term memory and working memory. *Long-term memory* stores the knowledge an individual accumulates over a lifetime, while *working memory* is the temporary workspace of human attention (Baddeley 1997). Long-term memory organizes knowledge in a network of bundles of related concepts called schemata (Brewer/Nakamura 1984) or frames (Neisser 1967). For example, a frame for picnic might bundle the concepts of food, eating, basket, blanket, outdoor, sunshine, and ants. Frames are connected within a network of concepts they share (Collins/Loftus 1975). A picnic frame might be connected to a beach frame via the concepts outdoor and sunshine. External sensory stimuli can activate frames, moving them temporarily into working memory. Once a frame is in working memory, it may activate other closely related frames (Collins/Loftus 1975).

However, working memory has only a limited number of slots, so at a given moment, it can contain only a limited number of frames, with each frame occupying one slot (Miller 1956; Barrouillet/Camos 2007). Thus, at a given moment, an individual can think about only a tiny subset of the knowledge stored in long-term memory. However, if frames appear together in working memory long enough and frequently enough, then chunking occurs (Belleza/Young 1989; Gobet et al. 2001). This means that multiple smaller frames combine to form a single, more sophisticated frame that takes up only one working memory slot. Then the individual can retain more knowledge without having more working memory. As smaller frames chunk into larger frames, and larger frames chunk into still larger ones, an individual moves up Bloom's revised taxonomy (remember, understand, apply, analyze, evaluate, and create).

That is why I expand the definition of knowledge to include '*expertise'* as an adequate construct helping to precisely differentiate between knowledge increases of HLL and LLL. Expertise refers to the level of domain knowledge about a specific topic. It does not exist in the abstract, because it refers to knowledge in a particular domain. Referring to specific modes of knowledge, expertise is more than quantifying the amount of facts within an individual's long-term memory in general. Along with the specific domain of knowledge, expertise classifies – in line with Bloom's revised taxonomy (Bloom 1956) (remember, understand, apply, analyze, evaluate, create).

Thus, I differentiate between the quantity of knowledge and the level of knowledge in a particular domain: The *quantity of knowledge* an individual holds about a specific topic might be measured, for example, by the number of facts and concepts a person can recall, and perhaps define. *Levels of knowledge* refer to the levels of Bloom's revised taxonomy, which are related to learners' cognitive efforts. The cognitive efforts of the learner increase from the lower levels to the higher levels (Krathwohl 2002). This leads to a differentiation between the level of complexity and the level of mastery of an individual's domain knowledge (Krathwohl 2002).

Level of complexity refers to the degree to which an individual understands the relationships between concepts in a particular knowledge domain (Krathwohl 2002). The concept of chunking helps to understand the increasing complexity. In working memory, an individual stores specific domain knowledge in the form of several chunks.

By using associations, an individual connects knowledge frames that chunk with one another and thus, builds relationships between knowledge frames. This way, cognitive schemas in the working memory of an individual mature (Gobet et al. 2001). Thus, learning on lower levels (such as remembering) refers to smaller frames that chunk into larger frames. Learning on higher levels (such as evaluating) refers to larger frames that chunk into even larger frames. As frames grow larger the complexity of relationships between knowledge concepts grows. A person with a high level of knowledge might, for example, be able to make judgements in terms of internal evidence and external criteria, and to synthesize information into new patterns and alternative solutions. Using this definition of expertise, it would be possible for a non-expert to have a greater quantity of knowledge on a topic than an expert, while the expert would have a higher level of knowledge.

Level of mastery means that mastering the simpler levels is a prerequisite for mastering the next, more complex level of knowledge. Thus, mastery means that one has to understand basic domain knowledge first before being able to understand more difficult domain knowledge. Full mastery is attained if an individual has built multiple layers of understanding, one upon another, until no new domain knowledge remains to be learned about that topic. This working definition may help to develop appropriate learner assignments (instruments) that analyze whether learners improve their performance on lower levels or higher levels of knowledge.

2.2 Conceptual Foundations of Collaboration Engineering

In order to develop reference processes for PL a design methodology is needed. As described in section 1.1 reproducible collaborative processes can – rather than impeding group performance – increase the number, quality, and creativity of ideas a group creates under certain conditions. In addition, they can improve the quality of work products while reducing cognitive load (Dennis/Nunamaker Jr/Vogel 1990; Fjermestad/Hiltz 1998; Jerry Fjermestad 2000; Briggs et al. 2013). To leverage the potentials from CE for reference processes for PL, a theory transfer is needed. It is important to understand the mechanisms from CE in order to be able to apply them to a new domain – the domain of PL. Therefore, I describe the foundations and potentials of CE in the subsequent subsections and describe the Six-Layer Model of collaboration as a design methodology. Additionally, I refer to indicators of collaboration process quality that help to evaluate the effectivity of collaborative processes.

2.2.1 Conceptual Foundations and Definitions

To understand the conceptual foundations of CE, an understanding of some definitions is inevitable.

Collaboration

The collaboration of two or more people is known to be a critical skill and a key driver of organizational and individual performance (Vreede/Briggs/Massey 2009a; Kolfschoten et al. 2014). According to scholarly literature, collaboration is characterized by joint efforts toward a common goal (Briggs et al. 2006). A goal is a desired state or outcome (Locke/Latham 1990). Two or more individuals combine their efforts to achieve such a desired state or outcome. Therefore CE researchers define collaboration as "joint efforts towards a group goal" (Briggs et al. 2006; Vreede/Briggs/Massey 2009a).

Going one step further, Leimeister (2014) defines *collaboration* as the work of two or more individuals that is conscious and tactically aligned to achieve a common group goal. To achieve the group goal necessary activities are communication, coordination, and cooperation (see Figure 4).

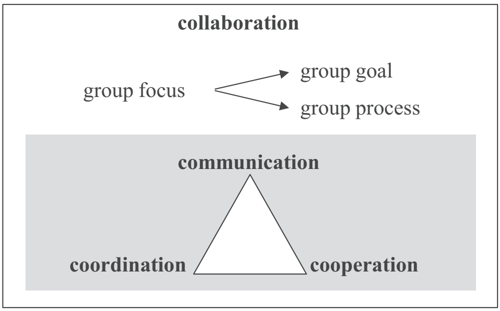


Figure 4: **Definition of Collaboration**
Source: Leimeister (2014)

Communication refers to the behavior of two or more individuals and their interactions aimed at transferring information in order to achieve a shared understanding (Leimeister 2014). *Coordination* refers to the communication processes that are necessary to organize decentralized actions and decisions from interdependent organizational units in order to achieve a goal. It is possible that cooperating systems achieve a goal that was not directly initiated by the involved individuals. Coordinated systems can work in parallel and unaffected by each other (Leimeister 2014). *Cooperation* refers to the activities of two or more individuals that are balanced in a conscious and planned way with the aim of achieving a common goal (Leimeister 2014).

Collaboration Engineering

The intention of CE is to design collaborative processes for practitioners before they start their work. By doing so, CE aims to optimize the actions that groups want to take to be productive, and to minimize the actions that groups do not want to take because they make them unproductive (Koch/Schwabe/Briggs 2015). Scholarly literature defines *collaboration engineering (CE)* as *"an approach to designing collaborative work practices for high-value recurring tasks, and deploying those designs for practitioners to execute for themselves without ongoing support from professional facilitators"* (Briggs et al. 2006). This definition of CE specifies the aim of CE in more detail. CE packages professional facilitation expertise without the ongoing help from professional facilitators (Briggs et al. 2006; Vreede/Briggs/Massey 2009a). The definition of CE comprises several elements that clarify the intention and understanding of the mission of CE. These elements are illustrated and described in more detail in the following (see Table 3).

Work practice	A set of actions carried out repeatedly to accomplish a particular task.
To design (verb)	To create, document, and validate a prescription (= collaborative process design) for a work practice.
Design (noun)	A written statement (usually a document) defining the sequences and logic set of structured steps for attaining a group goal, and the conditions under which these steps will be executed. Each step refers inter alia to a description of group members, practitioner tasks, and instructions. In its documentation, the design must be simple and clear. It is to be transfered to a practitioner.
High-value task	A task from which an organization derives substantial benefit or forestalls substantial loss by successful completion.
Recurring task	A task that must be conducted repeatedly, and that can be completed using a similar process design each time it is executed. However, all aspects of every instance of the task must not be similar.
Deployment	Implementation of the collaborative process design with the aim of creating a self-sustaining practice within an organization.

Table 3: Definition of Key Concepts of Collaboration Engineering
Source: adapted from Briggs et al. (2006) and De Vreede / Briggs/ Massey (2009a)

Consequently, a collaborative process design has the power to enable practitioners who conduct the collaborative process design to achieve results similar to those of professional facilitators. The collaborative process design packages collaboration expertise in a way that practitioners can execute the work practice without having to master facilitation skills (Vreede/Briggs/Massey 2009a).

2.2.2 Roles in Collaboration Engineering

Since CE aims at designing and deploying collaborative work practices for high-value recurring tasks (Vreede/Briggs/Massey 2009a), CE literature differentiates between three roles: facilitator, collaboration engineer, and practitioner (see Table 4).

<table>
<tr><th></th><th>One time ad hoc collaborative processes</th><th>Recurring high-value collaborative processes</th></tr>
<tr><td>Develop the collaborative process design</td><td rowspan="2">Facilitator</td><td>Collaboration engineer</td></tr>
<tr><td>Conduct the collaborative process design</td><td>Practitioner as facilitator</td></tr>
<tr><td>Participate in the collaborative process</td><td>Practitioner as participant</td><td>Practitioner as participant</td></tr>
</table>

Table 4: Roles in Collaboration Engineering
Source: Leimeister (2014)

Facilitator

A *facilitator* has facilitation expertise. They are able to design and conduct one time ad hoc collaborative processes and help a group attain the group goals (Briggs et al. 2006). They execute their own collaborative process designs without aiming at creating the design to be transferable to other facilitators (Briggs et al. 2006). Their professional expertise and skills allow facilitators to monitor the requirements of a task and the needs of a group as well as to make group interventions on the fly (Briggs et al. 2006). Consequently, they are able to adapt their collaborative process to changing conditions (Briggs et al. 2006).

Collaboration Engineer

A *collaboration engineer* designs collaborative work practices and deploys the design to practitioners in order to ensure transferability (Briggs et al. 2006; Vreede/Briggs/Massey 2009a). They make sure that practitioners can execute the design on their own without the ongoing support of an expert facilitator (Briggs et al. 2006; Vreede/Briggs/Massey 2009a). Against this background a collaboration engineer has to cope with design challenges beyond those faced by a facilitator (Briggs et al. 2006;

Vreede/Briggs/Massey 2009a). The collaboration engineer has to ensure that their design will move a group to achieve its goals (Briggs et al. 2006; Vreede/Briggs/Massey 2009a). The main challenge is to make the design simple, flexible, and robust so that practitioners can execute the design (Briggs et al. 2006). Moreover, the design must be predictable so that it yields high-quality outcomes when it is executed by practitioners (Briggs et al. 2006; Vreede/Briggs/Massey 2009a).

Practitioners

The third role refers to *practitioners* who are domain experts. Those practitioners are not experts in designing collaborative processes for themselves or for others. Their role is to execute a well-designed collaborative process (Briggs et al. 2006; Vreede/Briggs/Massey 2009a). Practitioners are also participants of a collaborative process.

2.2.3 Six-Layer Model of Collaboration

The heart of the CE design methodologies is the Six-Layer Model of collaboration (Briggs et al. 2014b), which considers collaboration processes at six different levels of abstraction. At each layer, there are different phenomena of interest, and thus different design concerns, metrics, theories, modeling conventions, design patterns, best practices, and worst practice. To design a collaborative work practice such as reference processes for PL it is important to follow the layers from the top to the bottom. All layers depend on each other. Changes in one layer will influence the other layers (see Figure 5) (Briggs et al. 2014b).

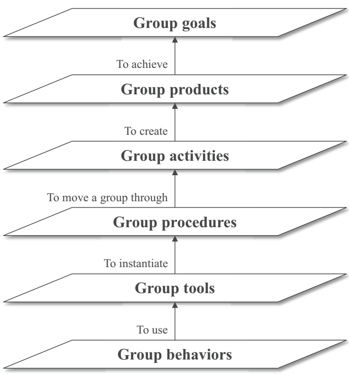


Figure 5: The Six-Layer Model of Collaboration
Source: Briggs et al. (2014a)

The first and most abstract layer, *group goals*, concerns the goals that group members commit to and which are achieved by group effort, the private goals of individual group members, and goal congruence, meaning the degree to which individuals perceive that working toward the group goals would be instrumental to the attainment of their private goals. A goal is a desired state or outcome. Goal congruence motivates effort toward group goals (Briggs et al. 2014b).

The second layer, *group products*, concerns the tangible or intangible work products created by the group in order to attain group goals. The same group goals may be attained by a variety of deliverables, so key design concerns at this level are the degree to which creating the group deliverables would achieve the group goals, the levels of time, effort, and resources required to create the deliverables, and the degree to which the choice of deliverables increases or decreases goal congruence (Briggs et al. 2014b).

The third layer, *group activities*, concerns the structure of the tasks a group must execute to create its deliverables, and the conditional logic for the order of the task execution. Key concerns here are the degree to which the activities would produce the deliverables, the levels of difficulty for the tasks, the effectiveness and efficiency of the activity design, and the impact of a given structure of activities on goal congruence (Briggs et al. 2014b).

The fourth layer, *group procedures*, concerns methods, strategies, and tactics, which a group will use to move through its activities (Briggs et al. 2014b). There are two key aspects to procedure design: collaboration patterns and collaboration techniques (thinkLets). Collaboration patterns characterize the ways groups move through their activities. CE researchers identify six such patterns (Vreede/Briggs/Massey 2009b):

- *Generate*: Move from fewer to more concepts in the shared set.
- *Reduce*: Move from many concepts in the shared set to fewer deemed worthy of further attention.
- *Clarify*: Move from less to more understanding of concepts in the shared set.
- *Organize*: Move from less to more understanding of relationships among concepts.
- *Evaluate*: Move from less to more understanding of the utility of concepts toward goal attainment.

- *Build Commitment*: Move from fewer to more stakeholders willing to commit to a proposed course of action.

When designing procedures, collaboration engineers first maps a logical path through a group activity in terms of these six patterns. The next step is to either select from known techniques aimed at invoking these patterns, or to design new techniques better suited to the task. Collaboration engineers often draw from the techniques of thinkLets, a design pattern language (Briggs/de Vreede 2009). ThinkLets are named, scripted, techniques that create predictable, repeatable, and useful variations of the six patterns when practitioners work toward a goal. Some ideation thinkLets, for example, stimulate depth and detail, while others foster breadth and variety.

The fifth layer, *collaboration tools*, concerns the equipment and technologies a group uses in performing their activities (Briggs et al. 2014b).

The sixth layer, *collaboration behaviors*, concerns everything the individual group members should say and do with regard to the tools they use. These tools instantiate the techniques that invoke the patterns of collaboration that move them through their activities and that helps them create their deliverables to achieve their goals (Briggs et al. 2014b).

2.2.4 Documentation of Collaborative Processes Designs

To document a collaborative process design that can be transferred to practitioners, two concepts are existent: The Facilitation Process Model (FPM) and the Internal Agenda. The FPM describes the logical sequence of collaborative activities. The Internal Agenda describes the sequence of collaborative activities in more detail and helps a facilitator to proceed a group of practitioners through a collaborative work practice.

Facilitation Process Model (FPM)

The *FPM* focuses on the logical flow of the activities and the interdependencies between them (Vreede/Briggs/Massey 2009a; Leimeister 2014). An output from a former activity serves as input for a subsequent activity (Leimeister 2014). The intention of the FPM is to illustrate the amount of activities, and to give a brief description of each activity, including the thinkLet used and the pattern of collaboration (Leimeister 2014). The development of a FPM is important for several reasons: It provides a visual description and an overview of the collaborative process. Moreover, with a FPM a collaboration engineer is able to examine whether a collaborative process is complete (Leimeister

2014). To develop a FPM and to model the logical flow of a collaborative process several elements are existent (see Figure 6).

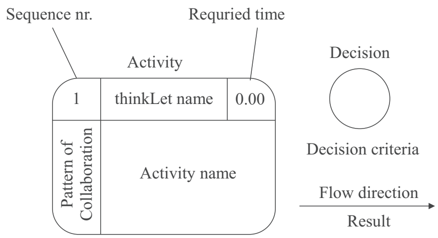


Figure 6: **Elements of the Facilitation Process Model**
Source: Vreede/Briggs/Massey (2009a)

In a FPM each activity is visualized by a rectangle which consists of five fields (Vreede/Briggs/Massey 2009a). There is a field with the number of the activity (Vreede/Briggs/Massey 2009a). In the center, there is a short description of the activity, represented by the activity name (Vreede/Briggs/Massey 2009a). It specifies what the group of practitioners has to do. The field on the left specifies the pattern of collaboration that will be addressed during the activity. The thinkLet name is noted on the top of the activity field (Vreede/Briggs/Massey 2009a). On the upper right corner there is a note for the required time to complete the activity (Vreede/Briggs/Massey 2009a). In case the collaborative process demands decisions to move to a former activity, a circle representing those decisions is added. In addition, there is a note for the decision criteria below each decision (Vreede/Briggs/Massey 2009a). The connection between the activities is illustrated by an arrow (Vreede/Briggs/Massey 2009a).

Internal Agenda

An internal agenda supports a practitioner to execute a collaborative process design. For that reason the internal agenda comprises more information than the FPM. The internal agenda refers to each activity and inter alia lists information on the preparation for the activity, instructions detailing the execution of the activity, and group products (Vreede/Briggs/Massey 2009a; Leimeister 2014). It specifies the efforts in a clear and understandable manner. Furthermore, it describes key information with regard e.g. to names of categories or assessment criteria (Leimeister 2014). In addition to the activities, the internal agenda should comprise breaks and presentations (Leimeister 2014). An example for the structure of an internal agenda is depicted in Table 5.

Nr	Time	Pattern of collaboration	thinkLet	Activity	Deliverable	Question/ Assignment	Tools

Table 5: **Structure of an Internal Agenda**
Source: based on De Vreede / Briggs/ Massey (2009a) and Leimeister (2014)

2.2.5 Process Restrictions of Collaborative Work Practices

Koch, Schwabe and Briggs (2015) point out that it is important to optimize the actions a group wants to take in order to become productive, and to minimize the actions that groups do not want to take and which make a group unproductive.

Against that background Briggs et al. (2013) defined certain process restrictions. Process restrictions limit a group in their interactions to actions that increase the likelihood to achieve group success (Briggs et al. 2013). In CE settings process restrictions occur in several ways (Briggs et al. 2013):

(1) Prescription of the sequence of activities (Briggs et al. 2013)

(2) Specification of procedures to complete an activity (Briggs et al. 2013)

(3) Guidance with regard to social norms (Briggs et al. 2013)

(4) Guidance on how to use the technology (Briggs et al. 2013)

(5) Prescription of functionalities of a technology (Briggs et al. 2013)

2.2.6 Indicators to Measure the Quality of a Collaborative Work Practice

To examine whether a collaborative work practice is well designed, and a practitioner is able to execute it, I rely on indicators for the quality of a collaborative work practice in the following. Table 6 refers to phenomena that are of interest for a CE researcher to examine whether their collaborative work practice and its design cope with the intention of CE (Briggs et al. 2006).

Sustained Use	A collaborative work practice or thinkLet is of sustained use if it can become a standard way to execute the collaborative task without the ongoing support from an expert facilitator (Briggs et al. 2006).
Predictability	A collaborative work practice or thinkLet is predictive if it can be executed as prescribed and if it creates similar variations on the used pattern of collaboration and group products across a variety of teams, tasks, and circumstances (Briggs et al. 2006).
Transferability	Transferability is given when individuals/practitioners who did not create a collaborative work practice or thinkLet are able to learn, remember, and execute it (Briggs et al. 2006).
Reusability	Reusability is given if a collaborative work practice can be used to solve problems other than those for which it was originally developed (Briggs et al. 2006).
Satisfaction	Satisfaction is given when practitioners who follow a collaborative work practice (Briggs et al. 2006). Satisfaction is apparent in measures for satisfaction with outcome [SO]; satisfaction with process [SP]; tool difficulty [TOOLDIF]; process difficulty [PROCDIF] (Briggs et al. 2013).
Efficiency	A collaborative work practice is efficient if putting in time and effort creates a feeling of adequacy and self-worth for practitioners that follow a collaborative work practice (Kolfschoten 2007).
Effectiveness	A collaborative work practice is effective if the collaboration imposes an outcome that complies with the expectations of the practitioners who follow the collaborative work practice (Kolfschoten 2007).
Productivity	Productivity is given if participating in the collaborative work practice imposes a positive feeling with regard to the own efforts in relation to the group outcome (Kolfschoten 2007).
Consistency	A collaborative work practice is consistent if the activities have a logical flow, and if the components of the design do not contradict each other (Leimeister 2014).
Completeness	A collaborative work practice is complete if there are no gaps remaining. A gap is existent if not all layers of the Six-Layer Model are respected in the collaborative work practice (Leimeister 2014).

Table 6: Indicators to Measure the Quality of a Collaborative Work Practice
Source: based on Briggs et al. (2006), Kolfschoten (2007), and Leimeister (2014)

3 RESEARCH STRATEGY AND METHDOLOLOY

3.1 Scientific Epistemology

The overall aim of the thesis is to develop and evaluate design artifacts. That includes a) designing and examining the conditions for PL in the form of a Flipped-Classroom Concept; b) an approach to design reference processes for PL; and c) designing and evaluating several reference processes for PL. The thesis therefore aims to make contributions to the body of knowledge in the domain of PL and CE. This leads to a research strategy that follows a Design Science Research (DSR) approach and guides the understanding of theory and truth in this thesis.

There is a discussion in scholarly literature on DSR and scientific epistemology whether DSR is a distinct paradigm or is more or less a hybrid paradigm that comprises characteristics of several paradigms (Niehaves 2007). I therefore provide in the following a brief description and classification of epistemological paradigms that are popular in scholarly literature. This will help clarify the underlying understanding of the theory and truth of this thesis. Scientific epistemology distinguishes between three paradigms – positivism, interpretivism, and critical realism. Each of these paradigms addresses different aims and research questions, research problems, and standards of truth (Koch/Schwabe/Briggs 2015) (see Table 7).

	Positivism	Interpretivism	Critical Realism
Reality	Reality is an objective category and can be observed and measured.	Social constructions form reality (e.g., humans that interact with each other; the meanings that individuals ascribe to their experiences). There is no objective reality.	Reality is historically constituted and now is under investigation. It is continuously critiqued, evaluated, and transformed. It is produced and reproduced.
Truth	Reality constitutes the ultimate truth.	Interpretations of reality and meanings in particular situations.	An understanding of the material conditions and interpretation forms the truth. The truth is inherent in statements that correspond to 'real-world' facts.
Knowledge	Knowledge is represented by facts that can be observed and measured.	Knowledge is represented by constructs and empirically testable theories (verification or falsification).	Knowledge is grounded in social and historical practices.
Under-standing in IS research and common methods	IS research is positivist in terms of formal evidence, measureable constructs, and hypothesis testing that help make deductions. The aim is to test theories to expand the prognostic understanding of the phenomena. Controlled laboratory experiments, field experiments, surveys, large-scale samples, and controlled laboratory experiments are suitable research methods.	IS research is interpretivist in terms of a focus on the understanding of the context of the system and its processes that influence each other, that is the context and the system. The aims are sense making and in-depth understanding. Field studies, ethnographic, phenomenographic, and ethnomethodological studies that examine humans in their social environments are suitable research methods.	IS research follows a critical realism in terms of longitudinal studies and studies of organizational processes and structures.

Table 7: **Paradigms of Scientific Epistemology**
Source: own illustration based on (Leimeister 2004; Weber 2004; Becker/Niehaves 2007; Koch/Schwabe/Briggs 2015)

DSR aims to make contributions to the body of knowledge of information systems that are employed in the practical domain. Against that background, DSR requires the research paradigms positivism and interpretivism (Niehaves 2007). Within a DSR project the evaluation focus can be on different aspects. In a DSR project the aim is to produce and evaluate a certain kind of knowledge that is inherent in a DSR artifact – the design knowledge or prescriptive knowledge (see section 3.2). Depending on the type of design knowledge the ‘truth’ will arise from the epistemological assumptions that underlie the evaluation (Niehaves 2007). While in early research stages the focus will be on examining the environment and practical domain, the evaluations in late research stages will focus on testing a DSR artifact. From that point of view, qualitative data collected by observations and interviews will characterize early stages. This refers to the interpretative research paradigm. The late stages will be characterized by hypothesis testing and field experiments and thus, will refer to the positivist paradigm.

Against that background DSR projects are characterized by epistemological diversity (Niehaves 2007). From a DSR point of view reality is formed by multiple, contextually situated alternative worlds (Vaishnavi/Kuechler 2015). Knowledge arises through making and refers to an objective construction within a context (Vaishnavi/Kuechler 2015). The knowledge building process occurs through several iterations (Vaishnavi/Kuechler 2015). Applied design and evaluation methods have a developmental character and measure the impact a design artifact has on the composite system (Vaishnavi/Kuechler 2015). To expand the scope of DSR in IS research, Briggs and Schwabe (2011) suggest to follow the positive paradigm and bear on exploratory, theoretical, experimental, and applied science to leverage the value and rigor of a DSR project. Following the activities of DSR cycles of a DSR project, all four modes of scientific inquiry can be addressed (Briggs/Schwabe 2011).

3.2 Design Science Research

3.2.1 Three Cycle View of Design Science Research

Hevner (2007) analyzed DSR research and identified three cycles that are closely related with each other when conducting a DSR project (see Figure 7). This recognition of the three cycles helps on the one hand to position and differentiate DSR from other research paradigms, and on the other hand provides a research framework to guide the research choices to achieve maximum impact of a DSR project (Hevner 2007).

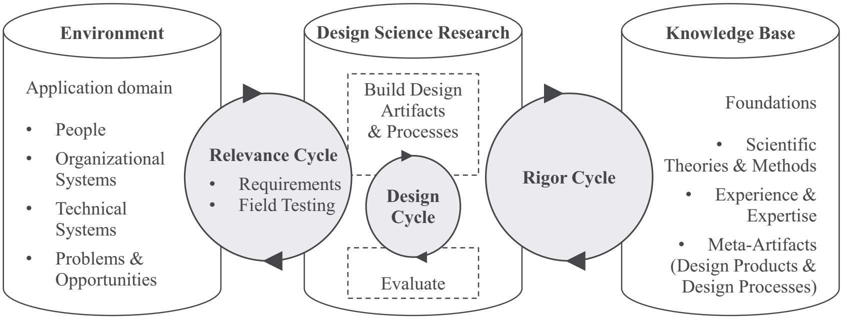


Figure 7: Design Science Research Cycles
Source: Hevner (2007)

A DSR project is grounded in the environment and thus, the practical domain as well refers to knowledge bases that provide the underlying kernel theories of research initiatives (Hevner 2007).

The *relevance cycle* serves as bridge between the contexts of the environment and the design science activities (Hevner 2007). This cycle helps define the conditions under which DSR artifacts manifest. The researcher examines the practical problem domain and derives requirements from practice. The results will determine the design choices of the subsequent cycles. After taking the design artifact to the field, the field testing will provide insights on whether additional iterations of the relevance cycle are needed or the derived requirements have to be refined (Hevner 2007).

The *rigor cycle* provides the knowledge base and the underlying kernel theories, and serves as bridge between the design choices and existing knowledge (Hevner 2007). These are scientific theories (e.g., state-of-the-art research in the application domain) and engineering methods (e.g., processes, approaches to design an artifact) (Hevner 2007).

The *design cycle* is iterated between the design and the evaluate activities of a DSR project (Hevner 2007). This cycle is the most demanding part for the researcher (Hevner 2007). The design and evaluate choices are informed by the insights from the rigor and relevance cycle. The researcher derives design choices, prepares evaluation procedures, collects as well as analyzes the data and draws them back to the environment (to complete the relevance cycle) and the knowledge base (to complete the rigor cycle).

3.2.2 Theory in Information Systems Research

Bearing the underlying epistemological paradigms and the use of DSR in this thesis in mind, it is important to clarify the understanding of theory. The Merriam-Webster dictionary defines theory as *"a plausible or scientifically acceptable general principle or body of principles offered to explain phenomena*" (Merriam-Webster 2016).

However, this understanding of theory only refers to a specific epistemological understanding and mainly to one of the modes of scientific inquiry. Against that background one can classify this understanding to the assumptions of theoretical research (Briggs/Schwabe 2011). From that point of view, this would lead to the assumption that theory only exists in terms of research that derives results that explain causal relationships. All other research activities that e.g. explorative describe phenomena or report correlations could not be classified as a theoretical contribution and thus, do not represent theory.

In contrast, DSR research provides a more differentiated understanding of theory (Gregor 2006; Gregor/Jones 2007; Gregor/Hevner 2013). Since the research strategy of the current thesis follows DSR paradigms, I focus my understanding of theory on the following descriptions and classifications of theory in information systems (see Table 8). From that point of view this understanding of theory also opens the chance to make contributions in the field.

Classification of Type	Characteristics
Theory for Analyzing	*Refers to what is.* The theory focuses only on analyzing and describing phenomena. It does not describe causal relationships among phenomena and does not make predictions.
Theory for Explaining	*Refers to what is, how, why, when, and where.* The theory only provides explanations. It does not make predictions and does not define and examine testable propositions.
Theory for Predicting	*Refers to what is and what will be.* The theory makes predictions on the basis of testable propositions. It does not comprise developed justificatory causal explanations.
Theory for Explaining and Predicting	*Refers to what is, how, why, when, where, and what will be.* The theory consists of predictions, testable propositions, and causal explanations.
Theory of Design and Action	*Refers to how to do something.* The theory provides prescriptions (e.g., methods, techniques, principles of form and function) to construct an artifact
Design Theory	*Refers to a generalizable and abstract body of prescriptive knowledge.* The theory describes the components of a design theory: purpose and scope, constructs, principles of form and function, and principles of implementation, testable propositions, justificatory knowledge, and expository instantiations.

Table 8: Taxonomy of Theory in Design Science Research
Source: based on Gregor (2006), Gregor and Jones (2007), Gregor and Hevner (2013)

In the context of the current thesis I refer to the understanding of theory outlined in Table 8 in my studies in sections 4, 5, and 6. In these sections I design and evaluate design artifacts that build 'theories of design and action' as well as 'design theories'.

Nevertheless, to clarify knowledge contributions that such a DSR theory will make, an understanding of the contribution types in DSR is vital.

3.2.3 Design Artifacts and its Knowledge Contributions

In the context of DSR projects contributions to the body of knowledge occur in the form of design knowledge. Gregor and Hevner (2013) differentiate between two types of design knowledge – descriptive knowledge and prescriptive knowledge (see Table 9). *Descriptive knowledge* refers to "what" the knowledge is about while *prescriptive knowledge* refers to the "how" of human-built artifacts (Gregor/Hevner 2013). Typically, descriptive knowledge informs the design choices that lead to prescriptive knowledge. Prescriptive knowledge of a DSR project consists of four types of prescriptive knowledge (Gregor/Hevner 2013): Constructs help to define and understand the problem, solution, and phenomenon of interest of the research (Gregor/Hevner 2013). Models describe the design that represents the problem and possible solutions (Gregor/Hevner 2013). Methods are algorithms or practices to complete a task. Instantiations represent the realization of a generalizable solution in the field (Gregor/Hevner 2013). A design theory represents an abstract coherent body of prescriptive knowledge and comprises constructs, models, methods, and instantiations (Gregor/Hevner 2013).

Descriptive Knowledge	Prescriptive Knowledge
• Phenomena (Natural, Artificial, Human) - Observations - Classification - Measurement - Cataloging • Sense-making - Natural laws - Regularities - Principles - Patterns - Theories	• Constructs - Concepts - Symbols • Models - Representation - Semantics/Syntax • Methods - Algorithms - Techniques • Instantiations - Systems - Products/Processes • Design Theory

Table 9: Descriptive Knowledge vs. Prescriptive Knowledge
Source: Gregor/Hevner (2013)

Gregor and Hevner (2013) propose three maturity levels of contribution types (see Table 10). Those are in relation to the design artifact as output of the research activities help to differentiate between the contribution types. The differentiation along the three maturity levels results from the level of abstraction and generalizability which is represented by the design artifact.

	Contribution Type	Design Knowledge (Artifact)
More abstract, complete, and mature knowledge	*Level 3.* Design theory (knowledge about embedded phenomena)	Design theory (mid-range and grand theories)
↕ ↕ ↕	*Level 2.* Nascent design theory (knowledge as operational principles)	Constructs, methods, models, design, principles, technological rules
More specific, limited, and less mature knowledge	*Level 1.* Situated implementation of artifact	Instantiation (software product, implemented process)

Table 10: Design Science Research Contributions
Source: Gregor/Hevner (2013)

Gregor and Hevner (2013) propose the knowledge contribution framework (see Table 11). With the maturity levels to classify contribution types in mind, a researcher can classify their design artifact in one of the fields of the knowledge contribution framework. The classification builds on solution maturity and the application domain maturity. This leads in total to four contribution types: routine design, improvement, invention, and exaptation (Gregor/Hevner 2013).

Solution Maturity	Application Domain Maturity: High	Application Domain Maturity: Low
Low	**Improvement** New solutions for known problems. → *Research opportunity and knowledge contribution.*	**Invention** New solutions for new problems. → *Research opportunity and knowledge contribution.*
High	**Routine Design** Known solutions to known problems → *No major knowledge contribution.*	**Exaptation** Known solutions to new problems (e.g. adopt solutions from other fields). → *Research opportunity and knowledge contribution.*

Table 11: **Design Science Research Knowledge Contribution Framework**
Source: Gregor/Hevner (2013)

In the current thesis I provide DSR studies that mainly make contributions to the quadrant of ‘improvement’ and ‘exaptation’. I report the main challenges of the application domain of PL. To systematically design PL processes and thus, to restrict learners in their learning behavior is still challenging and not trivial.

From a pedagogical point of view, designing PL activities in a reusable manner constitutes a known problem. Many lecturers face this problem and still struggle with integrating PL activities in large class setting. Designing and structuring PL activities and thus, restricting learners in their actions represents from a pedagogical point of view a new solution. Against that background the contributions of the thesis represent for a researcher in the domain of learning a contribution of the type ‘improvement’.

In contrast and from a CE point of view, I use mechanisms from CE do design reusable processes that enhance PL activities. From that point of view, this serves as the application of known solutions (collaboration techniques) from the CE domain to a new domain – the domain of PL. Against that background the contributions in this thesis represent for a CE researcher a contribution of the type ‘exaptation’. Nevertheless and from a CE point of view, the solutions will also have new elements that are specific for the domain, e.g. I propose methodologies that describe the preparation demands of a lecturer for conducting reference processes for PL. From that point of view, the transition between the contribution type of ‘exaptation’ and the contribution type of ‘improvement’ is fluent.

3.3 Methods to Create and Evaluate Design Artifacts

Given the research objectives of the thesis, I ground my methods for creating and evaluating design artifacts on DSR. The aim of DSR is to design and evaluate artifacts and make contributions to the body of knowledge in the form of prescriptive knowledge. Table 12 illustrates the methods that I used in the different stages of my research phases in order to achieve this goal. To illustrate the research phase, I refer to the cycles of the three-cycle view from DSR (Hevner 2007). Moreover, the table illustrates the outcome for each method in the form of the type of data that I derived by applying the method.

Research Phase and Methods	Outcome (Type of Data)
Relevance Cycle	
- Interviews with stakeholders and analysis of reports	State-of-the-Art Practice
Rigor Cycle	
- Literature review	State-of-the-Art Literature
*Design/Evaluate Cycle**	
- Requirement-based evaluation	Formal validation protocol
- Simulation	Formal validation protocol
- Walkthrough/ expert interview	Protocol of stumbling blocks
- Pilot scheme	Protocol of stumbling blocks Knowledge test and survey results
- Quasi-experiments	Knowledge test and survey results

* *Collection and analysis of data refer to qualitative and quantitative social research methods in order to derive insights in the phenomenon of interest of the several studies.*

Table 12: Overview of Methods for Creating and Evaluating Design Artifacts
Source: own illustration

Each of the studies described in the thesis follows a DSR approach. Consequently, I refer in each of the studies to several or all three cycles. In that context, I refer to the methods for creating and evaluating design artifacts in each study and describe in that context how I used the method in the different studies.

In the following, I will briefly outline the three evaluation methods (simulation, walkthrough, and pilot scheme) since they constitute common methods in CE research for validating collaborative work practices such as reference processes for PL. These methods need clarification since they are specific in the domain and refer to the different roles in collaboration engineering (see Table 13).

	Simulation	**Walkthrough (Expert Interview)**	**Pilot Scheme**
Costs	Low	Medium	High
Stakeholder	Collaboration Engineer	CE experts (Facilitators) Domain experts	Practitioner as - facilitator - participants
Scope	First validation of a collaborative work practice	Second validation of a collaborative work practice	Third validation of a collaborative work practice
Main characteristics	Stumbling blocks Logical process flow Formal CE aspects	Stumbling blocks Logical process flow Formal CE aspects Applicability in the field (e.g., instructions, time, tools)	Stumbling blocks Applicability in the field with practitioners (e.g. satisfaction, performance)
Type of data	Qualitative (formal validation protocol)	Qualitative (protocol of stumbling blocks)	Qualitative (protocol of stumbling blocks) Quantitative (test and survey results)
Measures	Judgements of sustained use, predictability, transferability, reusability, consistency, completeness, efficiency, effectiveness		Satisfaction measures, outcome measures (e.g., expertise [LLL, HLL], productivity, team performance efficiency, effectiveness)

Table 13: Overview of Validation Methods in Collaboration Engineering
Source: own illustration based on Leimeister (2014)

4 APPLICATION DOMAIN OF PEER LEARNING: Flipped-Classroom Concept – Redesigning Large Classes to Activate the Learner and to Create Conditions for Peer Learning [4]

4.1 Flipped-Classroom Concept in the Context of the Thesis

In section 4 of my thesis I will address my first research question:

> What are basic conditions for a teaching-learning concept that provides opportunities to leverage the power of peer learning in large classes? *(Application domain)*

Answering RQ1 means to go back to the starting point of my thesis. This will create an understanding of the application domain and the challenges of enhancing HLL effects in large classes. Large classes that mainly focus on factual knowledge and are characterized by little learner activation are still common and widespread. PL activities are a promising solution to activate the learner and to stimulate HLL effects in this context. An understanding of this application domain, meaning large classes, therefore, is important in order to be able to create conditions to integrate PL activities. But creating the conditions for PL in large classes is only a first step which will lead to fundamental insights into the challenge to make PL activities – that are commonly known to be difficult to implement and to predict, and that are rather complex – reusable, transferable and thus appropriate for large-class settings. These insights are important because they justify the demand to develop PL reference processes. From that point of view reference processes for PL, and thus, systematically designing PL activities in a predicable manner, constitutes from a DSR point of view a set of unsolved problems.

To answer RQ1 and to gain insights into the demands mentioned above, I conduct a study that develops and evaluates the design artifact of the *Flipped-Classroom Concept* by following a DSR approach (Peffers et al. 2006b; Gregor/Hevner 2013). The flipped classroom is a teaching-learning concept that describes how to activate learners and how to create the conditions for implementing PL activities in large classes. The results of the study presented in this section will provide further insights into the challenges of

[4] The insights presented in this chapter are partly based on different papers on this topic: (Oeste et al. 2014; Lehmann et al. 2015; Oeste et al. 2015b). Thanks to my collaborators and reviewers of the ICIS 2014, the AoM Annual Meeting 2015 and the HMD Journal. Thanks to all participants for participating in the evaluation of the Flipped-Classroom Concept.

using PL in large-class settings and will open the set of unsolved problems inherent in reference processes for PL and designing them in a replicable manner.

4.2 Study Outline and Research Approach

Universities have to provide high-quality education in order to meet the demand for highly qualified future employees. However, they face major challenges because of increasing student numbers and the requirement of cost savings. As a consequence, class sizes grow larger. These large-scale lectures lack to activate the learner, focus on factual knowledge on the lower levels of Bloom's revised taxonomy, and are less learner-centered. Interaction and collaboration are important factors to enable HLL on the upper levels of Bloom's revised taxonomy, such as to *apply, analyze, evaluate* and *create* knowledge, and are the prerequisite to educate highly qualified future employees. The current section outlines a study that I ran in 2014 and 2015 at a German university. The aim of the study was to develop and to evaluate a design artifact in the form of a Flipped-Classroom Concept. The study was based on a DSR approach (Hevner et al. 2004b; Peffers et al. 2006a), in particular on the DSR approach by Peffers et al. (2006a) (see Figure 8). I also followed the theory-driven design approach from Briggs (2006) to ground my research on the theory of interaction and to depart from pedagogical-driven design principles in order to overcome the lack of interaction and to create conditions to implement PL and thus to enable HLL.

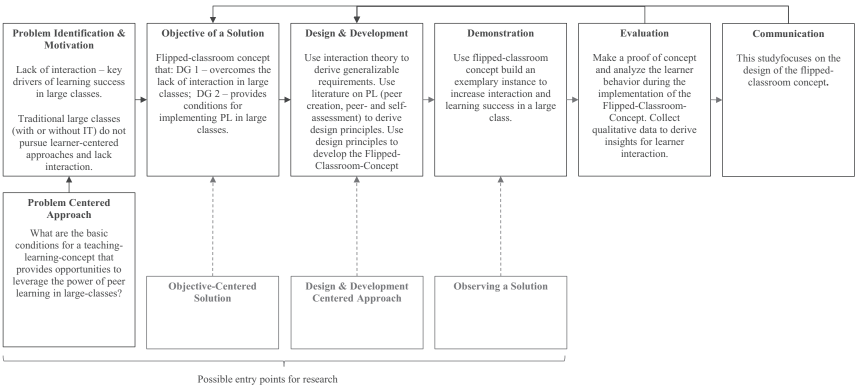


Figure 8: **Research Approach for Developing the Flipped-Classroom Concept**
Source: adapted from Peffers et al. (2006a)

In the remainder of this section, I will describe the study as follows: In section 4.3 I will focus on the '*problem identification phase*' and on the '*objective of solution phase*'.

First, I will give an introduction on the application domain of large classes characterize the relevance of research in that context (see section 4.3) and outline concepts from the body of literature that can offer solutions (see section 4.4). I will close with a solution statement and describe the aim of the study. In section 4.5 I will focus on the '*design and development phase*'. To guide the design choices to develop the Flipped-Classroom Concept I will address related work from interaction theory and PL in section 4.5.1 and 4.5.2. Based on insights from the body of literature I draw from requirements from interaction theory and PL-driven design principles. In section 4.5.3 I will illustrate the Flipped-Classroom Concept as a generalizable solution. In section 4.6 I will illustrate the '*demonstration phase*' and give a brief outline of the exemplary instance of a Flipped-Classroom Concept and its implementation in a German large class setting with undergraduate information systems students. To address the '*evaluation phase*' I will describe the evaluation and focus on its methodological underpinnings as well as its results from qualitative data (see section 4.7). I will continue with the '*communication phase*' and discuss the results in section 4.8. In section 4.9 I will summarize the main findings and illustrate the limitations of the study. I will close the section by outlining the implications for research and practice in general and with respect to the next steps of my thesis.

According to the types established by Gregor and Hevner (Gregor/Hevner 2013), this work constitutes a contribution of the type 'improvement' and more precisely a 'theory of design and action' (classification and description of contribution types see section 3.2.3. I propose a blueprint for a blended learning flipped classroom to redesign large IS classes, to recognize the important role of peers in the student journey, and to improve interaction. The Flipped-Classroom Concept for large classes adopts a learner-centered approach and integrates interaction to enable HLL effects. It contributes to research by developing a reusable Flipped-Classroom Concept that overcomes the lack of interaction and creates conditions for PL. It redesigns large IS classes and its learner-centered approach enables transfer of factual knowledge up to metacognitive knowledge within several interaction sequences. It helps to enable HLL in a way that lecturers receive insights on how to conduct the Flipped-Classroom Concept and learners on how to follow learning activities. This way the results also open and justify the set of unsolved problems inherent in reference processes for PL and systematically designing them. Along with DSR (Gregor/Jones 2007), Table 14 summarizes the knowledge contributions of the Flipped-Classroom Concept as follows:

Design Artifact	Flipped-Classroom Concept	
Contribution Type	Design Theory – Theory of Design and Action	
DSR Knowledge Contributions	*Purpose and Scope*	Traditional teaching-learning concepts for large classes often lack learner centricity and conditions to train HLL. The design goal of the study is to develop a Flipped-Classroom Concept for large classes that DG1 - overcomes the lack of interaction; and DG 2 - provides the conditions for implementing PL to allow training HLL.
	Construct	3 types of interaction.
	Principle of Form and Function	A Flipped-Classroom Concept as a generalizable solution creating conditions for PL for HLL in large classes. It comprises requirements, design principles, and a blueprint of a flipped classroom for large classes.
	Testable Hypothesis	The Flipped-Classroom Concept activates the learner by overcoming the lack of interaction by integrating PL mechanisms allowing training HLL.
	Justificatory Knowledge	To guide my design choices, I draw from literature on PL, interaction theory, and teaching-learning concepts.
	Expository Instantiation	A prototype of the Flipped-Classroom Concept, the flipped-classroom protoype, was implemented in a large class by using Moodle.

Table 14: Flipped-Classroom-Concept and its Knowledge Contributions
Source: own illustration

4.3 Relevance and Objective of the Study

4.3.1 Challenges of the Application Domain of Large University Classes

A university as the highest educational institution is responsible for providing high-quality education to the employees of future daily business (Dreyer 2014). Management education must be of high quality, which means that the development of innovative management education is based on training skills and competences (Chiru et al. 2012). Innovative organizations use the highest level of their human capital (David/Foray 2003), which means that the sole use of knowledge transfer is not sufficient for a smart and innovative employee. Organizations demand highly qualified, educated employees in order to remain competitive on the market. For this purpose, special skills for daily business are necessary, including the following, according to García-Aracil and Van der Velden (2008): abilities for *negotiating*, *persuasion*, *organization, problem-solving*, *leadership*, *communication, teamwork, critical thinking, reflection,* and *self-regulated learning*.

At the same time, the number of students at universities increases and state funding declines (Ma et al. 2015). As a consequence of these trends, the size of university classes grows larger (Ma et al. 2015). In the current situation, universities face the challenge of growing cost pressure e.g. concerning the staff and they have to provide high-quality management education with available resources at the same time (Moore 2002a). Thus, large university classes with an uneven lecturer-student proportion (sometimes more than 100 students per lecturer) are still common and widespread (Leidenfrost et al. 2009).

Currently, the teaching of a high number of learners takes place in the traditional form of large-scale lectures or *massive open online courses* (MOOCs). With regard to technologies and the digitalization, that change the nature of work and thus, the demands for competences and abilities of future employees (García-Aracil/Van der Velden 2008) it is questionable, whether traditional large-scale lectures and MOOCs are able to cope with these new demands. The learning-teaching arrangements of traditional large-scale lectures are typically characterized by high anonymity, lack of interaction and teaching facutual knowledge (Grießhaber 1994; Lehmann/Söllner 2014). In contrast, inlearning-teaching arrangements like MOOCs, lecturers have to deal with a low persistence of learners and high dropout rates (Garavan et al. 2010a; Jordan 2014). Learners are left to themselves and teachers can only influence the teaching-learning process to a small extent. This is often accompanied by insufficient learning outcomes and unsatisfied learners (Lehmann/Söllner 2014). Additionally, when transferring knowledge in a large class or a MOOC, teachers often only address the lower cognitive levels of educational objectives, that is *remembering* and *understanding,* as distinguished by Anderson et al. (2001) in Bloom's revised taxonomy. This development is unsatisfactory since fundamental elements of learning success include the opportunity to ask comprehension questions, to get feedback and to apply the learning content to complex problem situations that open the possibility to share and defend one's position of learning content (Picciano 2002).

A solution for more learner-centricity in terms of LLL activities are computer-based tests with automatically evaluable multiple-choice tasks that do not call for any additional effort on the side of the teacher. Learners receive feedback during the teaching-learning process about their current learning progress. To apply, transfer and evaluate learning contents high cognitive levels of educational objectives (applying, analyzing, evaluating, and creating) as distinguished by Anderson et al. (2001) need to be respected. To consider the upper levels of educational objectives, means to take into account HLL activities that allow learners to comprehend contents in their complexity. Thus, learners should be an active instead of a passive part in the teaching-learning process. Interaction and PL are regarded as significant indicators in terms of HLL learning success (Moore et al. 1996), and positively influence the long-term satisfaction of learners (Hardless/Nilsson/Nuldén 2005; Alonso/Manrique/Viñes 2009). Pedagogical mechanisms are needed to assist PL activities to help learners apply, analyze, evaluate and create learning content. However, implementing interaction and collaborative mechanisms for PL and feedback into a large class poses various problems (Lehmann/Söllner 2014) – particularly, because those mechanisms are known to be complex and demand high lecturer resources and thus, are commonly only working in small classes. HLL is associated with a particularly high expenditure of time and resources and is regarded as not manageable in large classes.

4.3.2 Objective of the Study and Design Goals

To transform an IS classroom into a flipped classroom might offer solutions to the challenges outlined in the previous section and could enhance interaction and PL without massively increasing the workload for lecturers. Therefore, the design goals of this section are:

- *Design Goal 1: Develop a Flipped-Classroom Concept for large classes to overcome the lack of interaction, and*
- *Design Goal 2: Create conditions for PL in large classes.*

The Flipped-Classroom Concept will help lecturers to activate learners and to support them to train learning content on all cognitive levels of educational objectives. To make a flipped classroom transferable for large classes I use related work from MOOCs, in particular with regard to IT support. With an IT-supported flipped classroom it will be possible to satisfy the demand for high-quality education in large classes. Furthermore, the flipped classroom will be transferred to large classes. This intelligent use of IT seems to be a promising solution to optimize cost and time aspects for lecturers as well as to transfer the teaching-learning concept of the flipped classroom to a suitable setting for large classes. The learners acquire knowledge independently by means of online learning material, such as instructional videos and scripts. Performance assessments in the form of automatically evaluable tests give learners the opportunity to self-directedly review the acquired knowledge. The presence phases include more complex assignments that focus on the application, analysis, and discussion of the learning contents (Keengwe/Onchwari/Oigara 2014). The in-class lectures can comprise group and individual activities, discussions, and other learner-centered activities in order to implement the learning contents by means of important comprehension and clarification questions (Johnson et al. 2014), while conveying abilities for critical thinking, reflection, and communication (Garrison/Kanuka 2004a). Moreover, it is necessary to design the phases (online and presence) by means of meaningfully interlocking assignments (Strayer 2012) in order to ensure the application and transfer of knowledge.

To underpin the purpose of my study, and more precisely of my Flipped Classroom Concept, I describe in the current Table 15 how the Flipped Classroom Concept differentiates from traditional large classes. The table refers to the activities and efforts while running the Flipped-Classroom Concept:

	Flipped-Classroom Concept*	**Traditional Large-Scale Lectures**
Learner-Learner Interaction	High	Low
Learner-Content Interaction	High	High
Learner-Lecturer Interaction	Medium	Low
Educational Objectives	All levels	Lower levels
Knowledge Transfer	Factual and procedural knowledge	Factual knowledge
Skill Building	High, by means of group activities and collaboration with other learners.	Low, due to only little collaboration with lecturer and other learners.
Resource Expenditure	Medium, due to shortened presence phases for lecturer.	High, due to long presence phases for lecturer.

* Flipped-Classroom Concept is developed in the current chapter 4

Table 15: Flipped-Classroom Concept vs. Traditional Large-Scale Lectures
Source: based on Oeste et al. (2015b)

4.4 Theoretical Foundations: Flipped Classroom, MOOC, and SPOC

There is related work on teaching learning concepts available that illustrates the focus, most important mechanisms, and the conditions under which the teaching learning concepts manifest. For that reason, I illustrate in the following the main characteristics of flipped classrooms in relation to MOOCs and SPOCs.

In a *flipped classroom*, respectively inverted classroom (Strayer 2012; Gehringer/Peddycord 2013) or reverse teaching (Provenzano/Kagan 2007), the learners first prepare the learning contents at home. As a result, the learners contribute their prepared basic knowledge to the in-class lecture, which leaves valuable time for questions and discussions, as well as the application of the knowledge acquired through self-study (Provenzano/Kagan 2007; Strayer 2012). Thereby, the teaching method is aligned as more learner-centered. Moreover, presence phases allow for valuable comprehension questions as well as for discussions on specific content. It changes the conventional way of teaching and homework. The process of acquiring knowledge or learning contents takes place at home. Students are required to teach themselves basic knowledge as homework, while they solve tasks that are usually supposed to be homework in class. This means that from now on mastery activities are an integral part of the schedule in class. Outside of class, learners have access to online videos and learning material so that they study the subject matter on their own. In class, learners concentrate on applying and analyzing the subject matter they previously studied (Keengwe/Onchwari/Oigara 2014). This is realized via group or individual problem solving activities, group discussions, or other learner-centered activities that enhance critical thinking, problem solving skills, or discussing (Garrison/Kanuka 2004b; So/Brush 2008; Strayer 2012). The concept of flipped classroom therefore requires several aspects concerning the learning material and the motivation of the students. In order to ensure that students are prepared for the lessons in class, they are required to view the lectures at home. Door-quizzes or interspersing machine-scored questions in the videos can be obligatory to ensure their preparation. However, from the students' points of view, there are serious drawbacks. For instance, the recorded lectures could be too long or not helpful in order to handle more difficult course material, as well as the difficult link of online and presence portions of the course (Strayer 2012). Blinding these drawbacks out, a flipped classroom is regarded as more enjoyable learning experience, promises more confidence in the students' performances, and drives student motivation and responsibility in the learning process (Lage/Platt/Treglia 2000; Strayer 2012; Fox 2013). On the part of learners, a flipped classroom allows for better learning performances and fosters the interaction and learning motivation during the teaching-learning process (Strayer 2012), while providing potentials for resource-friendly and high-quality teaching on the part of the lecturers. This way, various advantages can be derived from an IT-based flipped classroom for large-scale lectures compared to traditional large-scale lectures.

In contrast to flipped classrooms, there are two other concepts that need to be considered for delineation (Martin 2012); firstly massive open online courses (MOOCs), and secondly small private online courses (SPOCs). *MOOCs* are mainstream courses accessible for all people worldwide interested in a topic (Wulf et al. 2014). The concept of *SPOCs* offers a restriction regarding the availability: large scales of people can participate in the online course, but it is not a course open to everyone. Hence, the possibility to join the course is provided to a selected group. Therefore, both concepts share certain aspects with the flipped classroom. Flipped classrooms adopt to some extent the online component of both MOOCs and SPOCs (Martin 2012), as well as the private component of SPOCs. In addition, flipped classrooms are coined by their blended character, linking online and offline learning activities for a holistic teaching and learning concept.

4.5 The Flipped-Classroom Concept

4.5.1 Generalizable Requirements for the Flipped-Classroom Concept

To achieve learner-centricity and activate the learner it is important to have an understanding of the term interaction and the interaction types that occur in a teaching-learning concept. The meaning of the term 'interaction' in the disciplines of sociology, education, and psychology addresses the interrelation between human beings and their communicative actions among each other (Bryant/Heath 2000). I refer to the work of Moore (1989), who differentiates between three types of interaction: learner-content interaction, learner-lecturer interaction, and learner-learner interaction. I adopt these three types of interaction and define interaction itself as learning activities including the exchange between learners, lecturers, and content (Moore 1989; Schrum/Berge 1997).

Learner-learner interaction describes the interaction among the learners themselves. It enables a direct exchange and fosters the individual reflection ability. By reflecting, learners will develop awareness for their own performance and they may realize own strengths and weaknesses. Feedback on one's own performance leads to an awareness and understanding of how to control the own learning.

Learner-lecturer interaction has its basis on prior research that has shown that learners who interact with their lecturers are more actively involved in the teaching-learning process (Wang/Haertel/Walberg 1990; Liu et al. 2003) and receive better results in the final exam compared to those who do not interact with others. The question-answer game is the classic form of interaction between learners and lecturers. The lecturer can actively include the learner in the teaching-learning process, as well as assess the learning progress by means of the answers while providing direct feedback. The learners have the opportunity to contribute their ideas and thoughts by initiating new thought processes (Morgan/Saxton 1991; Gagné/Yekovich/Yekovich 1993). Learners with low or intermediate previous knowledge profit from a high degree of interaction and achieve higher learning results (Snell 1999).

Learner-content interaction refers to an interactive setting in the learning-teaching environment. It can enhance learner motivation, attention, and participation in class, while fostering greater exchange between learners (Liu et al. 2003; Sims 2003). Thus, it is very relevant to follow a learner-centered approach in order to activate learners.

Table 16 illustrates the interaction types and the generalizable requirements that I derived from the interaction types.

Interaction Type	**Description**	**Generalizable Requirements (GR)**
Learner-Learner Interaction	Learners should have the opportunity to connect with their fellow students during the teaching-learning process by means of conversations and discussions (Alavi/ Marakas/Yoo 2002) in order to enhance motivation (Eisenkopf 2010) and learning success (Fredericksen et al. 2000; Moore/ Kearsley 2011). In collaborative assignments, students learn from each other and mutually create new knowledge (Topping 2005).	*GR 1.* Learners should collaboratively work on common material and create a joint product. *GR 2.* Learners should discuss among each other.
Learner-Lecturer Interaction	Lecturers should give advice and feedback to learners and need to retain an overview of their learners' performances (Bligh 1998). In addition, the teacher should verify which learning goals may or may not have been achieved. By interacting with lecturers, learners can request clarification of unclear points and lecturers can reinforce correct interpretation (Thurmond/Wambach 2004).	*GR 3.* Learners should receive feedback. *GR 4.* Learners should give feedback. *GR 5.* Learners should have the possibility to ask questions.
Learner-Content Interaction	This interaction form takes place when learners examine the course content (Moore/ Kearsley 2011) and take part in class activities (Thurmond/ Wambach 2004). Assignments regarding the learning content should be integrated in the learning-teaching environment. Factors that affect the learner-content interaction can be contact with the content (Leasure/Davis/Thievon 2000) and participation in class discussions (Jiang/ Ting 1999).	*GR 6.* Learners should get content-specific assignments to answer on their own. *GR 7.* Learners should get content-specific assignments to discuss among each other.

Table 16: Generalizable Requirements from Theory of Interaction
Source: based on Oeste et al. (2014), Oeste et al. (2015b), Lehmann et al. (2015)

4.5.2 Theory-Driven Design Principles from Peer Learning

Besides the aim of activating learners by increasing interaction and to stimulate collaborative activities in the classroom, it is important to respect pedagogical mechanisms of PL. Those mechanisms provide pedagogical guidance. Therefore, I take into account PL mechanisms comprising peer creation as well as peer- and self-assessment to develop the Flipped-Classroom Concept since PL is known to have the potential to enhance HLL. I theory-driven derive design principles from PL literature and then classify how the design principles address the GR from interaction theory (see Table 17). First, I briefly describe the PL mechanisms and based on this, I derive design principles that are outlined in Table 17.

Peer learning (PL): PL is based on theories of social constructivism and refers to learning with and from companions of an equal status, called peers (Topping 2005). A group of people (2 up to > 100 people) learn or attempt to learn something together through social interactions (Dillenbourg 1999). Social interactions, such as discussions with peers, foster reflection of knowledge concepts and enable cognitive processes (Arbaugh 2010) that offer positive effects for the peer: e.g., knowledge gains that are inherent in the improvement of communication skills. In this context, it is important that the peers learn to be responsible for their activities (Topping 2005). The responsibility has the potential to help the peers to improve interpersonal and communicative skills as well (Büttner/Warwas/Adl-Amini 2012). In general, PL is characterized by high learner-centricity (Hua Liu/Matthews 2005b). In most cases, a person with pedagogical know-how leads and assists the learning activities (Harris 1998). Very similar to PL is the concept of cooperative learning, which is more specific on how to structure assignments that the peers receive. The lecturer provides an extensive open-ended assignment. The learners have to prepare a group solution.

Peer creation (PC): PC focuses on the development of learning material. Peers develop learning material for other peers. PC comprises mechanisms of co-creation (Wegener/Leimeister 2012) that indicate first insights on how people create artifacts in the learning context. The peers add value to learning material by yielding their own knowledge in the form of learning content (Wegener/Leimeister 2012). For developing learning material, Wegener et al. (2012) identified key principles. Based on this and in order to develop reusable processes for documenting knowledge in a standardized and productive way Oeste et al. (2014) provide additional insights. This assumes that a lecturer clearly has to define the assignment and make peers accountable for their developed learning material. Otherwise, the peers would not be able to document necessary knowledge in a correct way.

Peer assessment (PA): Integrating knowledge transfer and knowledge verification concerning the high cognitive levels of educational objectives (apply, analyze, evaluate, and create) has the potential to support learners in their learning process. Knowledge verification on the high cognitive levels of educational objectives is characterized by assignments whose very complex solutions are created by the learner (e.g., extensive free text assignments, written statements, and essays) (Jaillet 2009). However, the knowledge verification of these assignments is time- and resource-consuming hence impossible to apply in a large-scale learning environment. While the learners would greatly benefit, the lecturer's workload would become unmanageable. However, using the role of peers provides high potential. PA opens the possibility to assess knowledge on the high cognitive levels of educational objectives. To enhance interaction, feedback, and individual learning success verification, PA and self-assessments (SA) are possibilities to provide formatively individual feedback to the learners as well as corresponding interventions by means of technical-based observation processes even in groups with a higher number of learners (Piech et al. 2013). In the case of PA, learners give each other feedback or credit points in terms of a performance according to specifically defined criteria (Boud/Falchikov 2007). PA turns learners into experts themselves and gives them a deeper understanding of the learning content (Sadler/Good 2006). Learners will develop an awareness for their own strengths and weaknesses and will be able to compare their own performances to others (Darling-Hammond/Ancess/Falk 1995). In addition, learners train their abilities to think critically (Block et al. 1971; Zoller 1993). Furthermore, with the support of computer-based tests (machine grading), learners can assess their individual learning success on their own without increasing the lecturer's workload (Terzis/Economides 2011). Those tests allow for SA and are characterized by a choice of solutions, e.g., multiple choice, true/false statements, assignment tasks, or error marking.

	Design Principles (D)	Generalizable Requirements (GR)
Peer Learning	D 1) *Shared group knowledge*: Put together a group of learners and reconcile them to the same level of knowledge.	GR 1
	D 2) S*ubtask independency*: Clear definition for an assignment with several independent subtasks for which the learners have to create collaboratively a solution.	GR 1, GR 6
	D 3) *Subtask forumlation*: Formulate open-ended-questions that guide learners to reflect knowledge concepts in its totality (refer to high educational objectives – apply, analyze, evaluate, create) – and provide clear instruction on how to interact with each other.	GR1, GR 2, GR 6, GR 7
	D 4) *Lecturer-centricity*: Select a person with pedagogical know-how (e.g., lecturer, tutor) to guide learners.	GR 5
	D 5) *Reciprocity*: Enhance reciprocity by providing tools and assignments that require direct interaction.	GR 2, GR 6, GR 7
	D 6) *Accountability*: Make peers accountable for their solutions by social pressure.	GR 2, GR 6
	D 7) *Solution access:* Correct false solutions and provide best-practice solutions.	GR 3, GR 5
Peer Creation	D 8: *Quality control*: Install feedback mechanisms to ensure correctness of outcome.	GR 1, GR 2
	D 9) *Knowledge verification*: Compare the knowledge base of peers by means of knowledge tests before collaboration.	GR 6
Peer Assessment	D 10) *Access to feedback*: Give learners the opportunity to give and receive feedback. Provide specific criteria to evaluate each other's performances anonymously.	GR 2, GR 3, GR 4, GR 6, GR 7
	D 11) *Task type*: Integrate assignments that presume reflection of complex learning content, address high educational objectives.	GR 2, GR 6, GR 7
Self-Assess-ment	D 12) *Computer-based knowledge checks*: Provide knowledge tests that automatically evaluate the individual performance.	GR 3

Table 17: **Design Principles for a Flipped-Classroom Concept**
Source: based on Oeste et al. (2014), Oeste et al. (2015b), Lehmann et al. (2015)

4.5.3 The Flipped-Classroom Concept as a Generalizable Solution

4.5.3.1 Overview: The Teaching-Learning Cycle

This section describes the Flipped-Classroom Concept as a generalizable solution. With respect to the design goals (*DG 1 – develop a Flipped-Classroom Concept for large classes to overcome the lack of interaction, and DG 2 – create conditions for PL),* the aim of the Flipped-Classroom Concept is to split structure in learning activities and thus, to provide guidance for learners about acquiring and training learning content. For that reason, a teaching-learning cycle guides the learners through their learning experience when acquiring and training learning content. A teaching-learning cycle recurs several times during a semester. Thus, each cycle does not include all learning content of the course. The learning content is divided among a number of cycles that a lecturer thinks to be appropriate (e.g., in cases of 6 appointments in the lecture hall, the lecturer will have to install 6 teaching-learning cycles). Thus, each teaching-learning cycle focuses on a specific amount of learning content and the learning activities meant to acquire and train the learning content are divided into four phases. Figure 9 illustrates the teaching-learning cycle of the Flipped-Classroom Concept with its four consecutive phases. Each phase addresses specific cognitive process dimensions, e.g., acquire factual knowledge in the first phase or transfer of procedural knowledge in the third phase. The design of the phases is designed in such a way that the learner successively builds up knowledge. To build up knowledge, a basic understanding is needed in the area of the lower learning level. This is done in phase 1. Building on this knowledge, the learner starts in phase 2 and is now able to apply knowledge and discuss with other learners at high learning levels. Consequently, learning objectives on higher process dimensions can only be achieved, if a learner passes through the whole cycle.

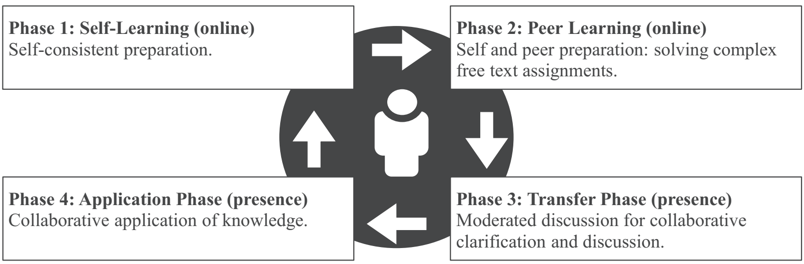


Figure 9: Teaching-Learning Cycle of the Flipped-Classroom Concept
Source: based on Oeste et al. (2014), Oeste et al. (2015b), Lehmann et al. (2015)

The overall goal is to actively get the learner involved in learning activities. Furthermore, I aim to get students prepared for self-directed learning: Outside of class, learners will prepare the learning content on their own with provided learning material, slides and learning videos. Within PL activities, students will work together creating answers to content-specific assignments. In class, the time is used for comprehension questions, valuable discussions concerning the collaboratively created answers, and further assignments to foster a deeper understanding of the learning content. For a learner, it is some kind of a journey in which he acquires and trains the learning content in its totality along all levels of educational objectives from Bloom:

- *Phase 1:* The aim of the first phase is to enable an acquisition of knowledge by self-consistent preparation of learning content by the learners themselves. It takes place online and allows learners to acquire knowledge by working through learning materials in the form of videos, slides, and scripts on their own.

- *Phase 2:* The aim of the second phase is to reflect the knowledge, to train critical thinking, and to apply the knowledge to complex problem situations in order to achieve HLL effects. To provide flexibility and transferability the phase takes place online. PL mechanisms are installed, and the learners collaborate with other learners and solve open-ended assignments that refer to the higher levels of Bloom's revised taxonomy (e.g. apply, analyze, evaluate, create knowledge).

- *Phase 3:* The aim of this phase is to deepen the understanding by asking comprehension questions and by discussing learning content in the lecture hall. Phase 3 mainly depends on the results of phase 2. The open-ended assignment solutions from the learners will be discussed in the lecture hall.

- *Phase 4:* The aim of this phase is to train specific learning content in small tutorial groups in presence.

Gregor (2006) suggests solution tables as the appropriate form of representations for a theory of design and action. Therefore I use tables (see Table 18, Table 19, Table 20, and Table 21) to illustrate the description of each phase of the teaching-learning cycle in more detail. Those descriptions aim to serve as a generalizable solution in the form of design pattern for instantiating the Flipped-Classroom Concept. For each phase, the tables explicitly illustrate the *conditions*, *intention*, *input and output*, *procedures* and the *tool* support. In that context I refer to the specific form of interaction according to Moore et al. (1989) and the educational objectives according to Bloom's revised taxonomy

(Krathwohl 2002). This helps to structure the Flipped-Classroom Concept and its collaborative activities in a reusable way (Bittner/Leimeister 2014; Oeste/Söllner/Leimeister 2014). As for pedagogical guidance, I illustrate for each phase the design principles that the phase meets. This way, the teaching-learning cycle with its description of the four phases provides a) a structured overview of learner activities; b) support for lecturers on how to build their own exemplary instance of a flipped classroom.

4.5.3.2 Phase 1: Self-Learning (Online)

In the first phase (see Table 18), a self-consistent preparation takes place and learners study the learning material on their own. This learning material consists of videos and slides in small units and is provided by the lecturer via LMS. This allows learners using the learning material independent of time and place. Furthermore, knowledge tests consisting of single and multiple-choice questions are offered via LMS, where learners automatically receive individual formative assessment. In case of unsatisfactory results, learners have the chance to repeat learning content by means of videos and slides.

Phase 1: Self-Learning (Online)		D
CONDITIONS		
Group mode	Individual	
Interaction type	Learner-content interaction	
Role of learner	Self-directed examination of provided learning material.	
Role of lecturer	Creates learning materials that refer to factual knowledge on the lower educational objectives and provides access to them via LMS.	
INTENTION		
Goal	Acquisition of learning content by examining learning material in order to cope with subsequent phases.	
Learning objectives	Remember, understand.	
INPUT vs. OUTPUT		
Input: learning material	Videos, slides, script, book, knowledge test.	
Output: learner deliverable	- Learners have increased their factual knowledge base. - Learners have received direct automated feedback from a knowledge test. - Learners have the same knowledge base. → Common knowledge base: Learners are prepared to start with phase 2.	D 9, D 12
PROCEDURES		
Instructions for learners	Work through learning materials and then complete a knowledge test to achieve feedback.	
Learner activities	(1) Learners examine provided learning materials. (2) Learners complete a knowledge test. (3) Learners receive an automated feedback on their knowledge test performance.	
TOOLS		
Functionalities	Learning materials that can be made available via IT (LMS). LMS with functionalities - To provide access to learning materials. - To create a knowledge test with single choice questions about the learning content.	

Table 18: Teaching-Learning Cycle – Phase 1: Self-Learning (Online)
Source: based on Oeste et al. (2014), Oeste et al. (2015b), Lehmann et al. (2015)

4.5.3.3 Phase 2: Peer Learning (Online)

After the learners have examined the learning materials that are provided in phase 1, they will be prepared for the next phase. In the second phase (see Table 19), learners need to prepare a solution for a part of an extensive open-ended free text assignment (each group is assigned to different assignment parts). For this, learners will work together in subgroups of up to 30 participants while using their own LMS collaborative working space. In addition, student assistants will control the learners' work in each group forum, guide the process in collaborative working, as well as provide help when needed. Each group needs to bring their solutions on slides, which are used as input for the next phase, which is held in presence (Janson et al. 2014). The assignment for phase 2 will be unlocked at a defined deadline in order to ensure that all learners have enough time to examine the learning content from phase 1 and thus, to start prepared into phase 2. Following a constructivist point of view on PL, the learners receive the necessary conditions to interact with each other. Instructions are open because learners should not be restricted in their learning experience.

Phase 2: Peer Learning (Online)		**D**
CONDITIONS		D 1, D 2, D 3, D 5, D 6, D 8, D 10, D 11
Group mode	Individual and subgroups (up to 30 learners)	
Interaction type	Learner-learner interaction and learner-content interaction	
Role of learner	Individual and subsequent collaborative preparation of a solution for one subtask from an open-ended assignment.	
Role of lecturer	Creates an open-ended assignment with four subtasks, installs subgroups in the LMS, and assigns a subtask to each subgroup. Assigns the same subtasks to more than one subgroup.	
INTENTION		
Goal	Application and transfer of learning content to a new problem situation inherent in an open-ended assignment.	
Learning objectives	Remember, understand, apply, analyze, evaluate, and create.	
INPUT vs. OUTPUT		
Input: learning material	Open-ended assignment on the learning content of the current cycle. The subtasks demand learners to apply, analyze, evaluate, and create knowledge to develop a solution. The assignment is a case with four independent subtasks that describe a real world problem. The lecturer assigns only one subtask for motivational and pedagogical reasons to each subgroup: - To solve all subtasks would overstrain learners. - The discussion quality in the plenary group in phase 3 will be enriched when different groups solve different subtasks.	
Output: learner deliverable	Learners trained learning content to achieve HLL effects. → Peer-created solution: Each subgroup develops and submits a consolidated solution for its assigned subtasks in the form of a slide show (5 slides).	

PROCEDURES	
Instructions for learners	To solve an open-ended assignment and to train learning content, learners register for the learning experience to receive a subtask. First, solve the subtask on your own; second, discuss your solution in your subgroup with your teammates. Thirdly, consolidate a common solution and submit it so that it can be discussed in the lecture hall.
Learner activities	(1) By using the LMS learners subscribe to a subgroup to get access to the assignment (subtask). (2) Learners receive instructions on how to: a) solve the assigned subtask on their own; b) discuss the solution in their subgroup; c) consolidate and submit a common solution of their subgroup. (3) Learners receive information that they will get to know the solutions of the other subtasks in the plenary discussion in phase 3.
TOOLS	
Functionalities	Open-ended assignment that can be made available via IT (LMS). LMS with functionalities - To subscribe to groups. - To assign different information/subtasks to subgroups. - To provide each subgroup with a shared working space to a) discuss solution aspects; b) create a slide show. - To allow each group to submit/upload a peer-created solution.

Table 19: Teaching-Learning Cycle – Phase 2: Peer Learning (Online)
Source: based on Oeste et al. (2014), Oeste et al. (2015b), Lehmann et al. (2015)

4.5.3.4 Phase 3: Transfer Phase (Presence)

After the learners have prepared a solution in their subgroups they can start with phase 3 (see Table 20). In case a group cannot deliver any solution, no answers can be presented and discussed in the plenary hall. This has negative consequences for all learners because nobody will receive the whole solution of the open-ended free text assignments. Therefore, it can be assumed that all groups deliver assignment-specific answers, otherwise social pressure among the learners would increase significantly. Phase 2 gives learners the flexibility to engage in a PL experience that is independent from time and place. Learners need to be aware that they have to develop and submit a peer-created solution. This way learners become responsible for their actions and receive some kind of social pressure. In order to avoid a situation in which there will be no submitted subtask solution, it is important that the lecturer assigns the same subtask to more than one subgroup. This way the lecturer can reduce the risk that there will be no solution that can be discussed in phase 3.

Phase 3: Transfer Phase (Presence)		D
CONDITIONS		
Group mode	Plenary group (up to 1,000)	
Interaction type	Learner-lecturer interaction	
Role of learner	Provides the necessary input in the form of peer-created solutions for the subtasks and actively engages in the plenary discussion.	
Role of lecturer	Selects exemplary solutions from all submitted subtasks, presents exemplary solutions, and moderates a plenary discussion. In case of no submitted solution, there will be no plenary discussion.	
INTENTION		
Goal	Collaborative plenary discussion to a) clarify and consolidate a correct solution for each subtask; b) achieve a deep and sophisticated understanding of learning content with HLL effects.	
Learning objectives	Remember, understand, apply, analyze, evaluate, and create.	D 3, D 4, D 7
INPUT vs. OUTPUT		
Input: learning material	Selection of exemplary peer-created solutions from phase 3 (some very good and some bad solutions).	
Output: learner deliverable	Learner has a deep and sophisticated understanding of the learning content and is able to evaluate its correctness and create solutions for new problem situations.	
PROCEDURES		
Instructions for learners	Listen to the lecturer, who presents exemplary peer-created solutions. Add explanations, ask comprehension questions, and engage in the plenary discussion.	
Learner activities	(1) Listen to the presentation of the solutions. (2) Engage in the plenary discussion by adding explanations and asking comprehension questions. (3) Note the solution for each of the four subtasks.	
TOOLS		
Functionalities	Laptop and projector to present exemplary peer-created solutions.	

Table 20: Teaching-Learning Cycle – Phase 3: Transfer (Presence)
Source: based on Oeste et al. (2014), Oeste et al. (2015b), Lehmann et al. (2015)

4.5.3.5 Phase 4: Application Phase (Presence)

After the plenary discussion in phase 3 learners have a sophisticated understanding of the learning content and achieved HLL effects. The last phase (see Table 21), collaborative application, is carried out in tutorials. These tutorials are held by student assistants in different subgroups consisting of the same learners who worked together previously in phase 2. In these tutorials, learning content and assignments regarding the application knowledge are mediated and practiced. The student assistants provide learners with individual feedback and give hints. However, in each lecture there will be learning content that requires application and collaboration in presence (e.g., modeling assignments on ERM, EPK). For that reason, phase 3 is delivered as a traditional tutorial that provides space for traditional PL activities.

Phase 4: Application Phase (Presence)		**D**
CONDITIONS		
Group mode	Subgroups	
Interaction type	Learner-lecturer interaction, learner-learner interaction, learner-content interaction	
Role of learner	Actively collaborates with teammates by applying learning content to modeling assignments and asks the tutor comprehension questions.	
Role of lecturer	Provides conditions for tutorials in subgroups: Creates modeling assignments, selects tutors, and books rooms.	
INTENTION		
Goal	Collaborative application of knowledge and methods on several assignments.	
Learning objectives	Remember, understand, apply, analyze, evaluate, and create.	D 1, D 3, D 4, D 7
INPUT vs. OUTPUT		
Input: learning material	Modeling assignments to apply learning content.	
Output: learner deliverable	Learner has a deeper understanding of learning content and is able to apply knowledge.	
PROCEDURES		
Instructions for learners	Participate in a tutorial and solve assignments for application of knowledge.	
Learner activities	(1) Learners join a tutorial. (2) Learners collaboratively apply learning content by solving modeling assignments with their teammates. (3) Learners ask the tutor comprehension questions.	
TOOLS		
Functionalities	A room as working space to solve modeling assignments.	

Table 21: Teaching-Learning Cycle – Phase 4: Application (Presence)
Source: based on Oeste et al. (2014), Oeste et al. (2015b), Lehmann et al. (2015)

4.6 Flipped-Classroom Prototype as Exemplary Instance

4.6.1 Context of the Flipped-Classroom Prototype

In order to evaluate the real-world feasibility, DSR requires that researchers develop an exemplary instance of their generalizable solution. In the following I describe the instantiation of the Flipped-Classroom Concept, which I name the *Flipped-Classroom*

Prototype. To evaluate the Flipped-Classroom Prototype in a large German university class I used qualitative data to gain first insights toward my design goals. Therefore, the focus of the evaluation is on the Flipped-Classroom Prototype which in turn serves as a case study.

The Flipped-Classroom Prototype was tested for the first time during the summer term 2014 at a German university in an IS introductory large class. The audience consisted of the students of that class. The class was usually attended by 150–300 undergraduate Bachelor students of economics.

To provide an understanding how the design of the new teaching-learning concept changed the traditional course format, and to give lecturers, that have a traditional course format as starting basis, a starting point for building a Flipped-Classroom Protoype, Table 22 gives a brief overview of the activating elements and resource demands of the new course format. The Flipped-Classroom Prototype changed the course format in various ways. Table 22 illustrates the main differences and similarities between the original course format and the Flipped-Classroom Prototype. The course was originally designed as a traditional large-scale lecture with high teacher centricity and the learning content was divided among the 12 presence sessions that were supplemented by tutorials. The tutorials were supervised by student assistants and comprised small subgroups working on modeling assignments. All learning content was taught during the presence time in the lecturer hall and provided by the LMS Moodle and made available as a script. This traditional course format insufficiently activates the learner and lacks to integrate the various forms of interaction. Moreover, it only limitedly assists the learner in the teaching-learning process by means of feedback. Without modification of the traditional approach, it is difficult to meet the challenges universities are faced with in terms of resource savings and increasing numbers of learners while at the same time providing high-quality teaching. Compared to the original course format the learning content of the Flipped-Classroom Prototype was divided among six teaching-learning cycles. For each of the cycles the learning content was revised to cope with the demands of the Flipped-Classroom Concept. That means, that the original learning content was taught by videos for self learning (phase 1). Another similarity are the modeling assignments that become addressed in phase 4 of each cycle. New learning content and opportunities to train HLL were integrated in phase 2 and 3.

	Flipped-Classroom Prototype	Original Course Format
Grouping	Plenary group (up to 300) 12 subgroups (up to 30)	Plenary group (up to 300) 12 subgroups (up to 30)
Lecturer resources	1 lecturer 4 student assistants	1 lecturer 4 student assistants
Timeline	6 teaching-learning cycles: Each provides the chance to interact with other learners or the lecturer: - phase 1 [online]: 6 self-learning , - phase 2 [online]: 6 PL in subgroups, - phase 3 [presence]: 6 presence session, - phase 4 [presence]: 6 tutorials.	12 presence sessions 4 tutorials
Learning material	- phase 1 [online]: script*, videos, knowledge test - phase 2 [online]: open-ended assignments - phase 3 [presence]: / - phase 4 [presence]: modeling assignments* ** similar learning content*	Script, modeling assignments
Tool for learning material access	Moodle	Moodle
Tool support for self-assessment	Moodle knowledge tests	None
Tool support for collaborative working space	72 Moodle forums (for each subgroup in each teaching-learning cycle)	None

Table 22: Flipped-Classroom Prototype vs. Original Course Format
Source: own illustration

4.6.2 Phase 1: Self-Learning (Online)

Learning materials in the form of videos, a revised script and knowledge tests were developed in order to transfer all knowledge and learning content and to satisfy the demand of phase 1 from the teaching-learning cycle of the Flipped-Classroom Concept. Those learning materials were divided among six cycles. In each cycle the students have the chance to self-directedly acquire knowledge in phase 1 and to assess their learning performance by watching videos, reading the script and completing a knowledge test that provides automated feedback. The access to all learning materials takes place via Moodle. For that reason, a Moodle course was installed. The structure of the Moodle course represented the six teaching-learning cycles. Figure 10 illustrates the Moodle course with an example of cycle 1- phase 1, and shows how the students can access the learning materials

Figure 10: **Flipped-Classroom Prototype: Teaching-Learning Cycle (Phase 1)**
Source: own illustration

4.6.3 Phase 2: Peer Learning (Online)

To provide the conditions for enabling PL activities for each cycle 12 subgroups with a size from 2–30 students were created in Moodle. In each cycle each subgroup had access to a Moodle forum. The students subscribed to a subgroup and automatically received access to the Moodle forum for their subgroup. This way the students received different subtasks and information as well as had a collaborative working space to create a solution. For each of the six teaching-learning cycles an open-ended assignment with four subtasks was developed. In total, six open-ended assignments, each with four subtasks (24 subtasks) were developed to support students to achieve HLL during PL activities. The subtasks were assigned to the subgroups by using the Moodle forum. The lecturer posted a subtask in each forum. This way there were three subgroups that worked independently on the solution of a single subtask. Thus, the likelihood that at least one subgroup submits a solution was high. The development of the peer-created solutions took place within several Moodle forums. Table 23 summarizes the main characteristics of the grouping and subtasks of phase 2 of the Flipped-Classroom Prototype.

	Per teaching-learning cycle	**Among all 6 teaching-learning cycles**
Total student capacity	360	360
Number of subgroups	12	12
Size of subgroups	2 to 30	2 to 30
Number of Moodle forums	12	72
Number of subtaks	4	24

Table 23: Flipped-Classroom Prototype (Phase 2): Characteristics
Source: own illustration

Figure 11 outlines the main characteristics of the Moodle environment of the Flipped-Classroom Prototype in phase 2. To avoid information overload the students subscribe to a single subgroup and then only see the forum of their subgroup and not those of all twelve forums.

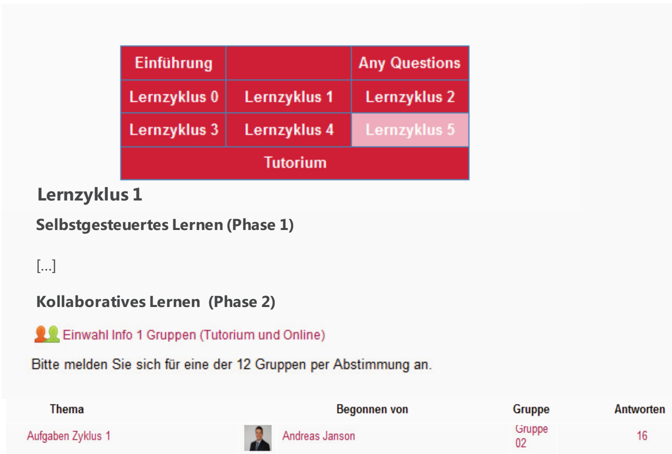


Figure 11: Flipped-Classroom Prototype: Teaching-Learning Cycle (Phase 2)
Source: own illustration

4.6.4 Phase 3: Transfer Phase (Presence)

Phase 3 of the Flipped-Classroom Prototype was a presence session in the lecturer hall. The lecturer downloaded the peer-created solutions from phase 2 and selected exemplary solutions for a presentation in the lecture hall. The plenary discussion then took place in the lecture hall as illustrated in Figure 12.

Figure 12: Flipped-Classroom Prototype: Teaching-Learning Cycle (Phase 3)
Source: own illustration

4.6.5 Phase 4: Application Phase (Presence)

Phase 4 did not differ from the traditional course format. For each cycle, 12 tutorials were installed which offered presence meetings at the university and trained how to solve modeling assignments. A student assistant guided each tutorial. Participants of one tutorial group also worked together in the subgroups of phase 3. This way, each student joined a tutorial in each cycle.

Figure 13: Flipped-Classroom Prototype: Teaching-Learning Cycle (Phase 4)
Source: own illustration

4.7 Evaluation of the Flipped-Classroom Prototype

4.7.1 Study Structure and Data Triangulation

4.7.1.1 Context and Participants Background

The Flipped-Classroom Prototype with its teaching-learning cycle was tested for the first time during the summer semester of 2014 at a German university in an IS introductory large-scale lecture. A total of 174 undergraduate business students attended the course and participated in the learning experience of the flipped classroom. The university LMS provided learners access to all learning materials.

The students completed six teaching-learning cycles among the whole semester. Each cycle had duration of two weeks and comprised the four consecutive phases: In the first phase, namely the *self-learning phase*, the learners studied learning material on their own and independently acquired the learning contents that are usually taught in presence in traditional lectures in self-study via instructional videos and scripts. In addition, the university's LMS Moodle provided various multiple-choice assignments in the form of computer-based knowledge tests for self-assessment. The second phase, the *peer learning phase*, comprised of complex open-ended assignments for HLL, which required highly cognitive thinking processes and addressed the learning contents on the high levels of educational objectives. The learners were divided into 12 groups to collaboratively find solutions. The third phase, the *transfer phase*, was carried out in presence and served to clarify questions and ambiguities that came up during the first two phases in a lecturer-moderated plenary discussion. For this purpose, the group solutions of the open-ended assignments were presented by the lecturer, who also highlighted content strengths and weaknesses during the discussion with the learners. The fourth phase respectively the *application phase* took place in presence in 12 tutorial groups. Learners of one tutorial group also worked together in the peer-learning phase. The tutorial covered more complex lecture-related contents such as data modeling and business process management (BPM).

4.7.1.2 Selection of Participants and Data Collection

The whole course format was changed into a flipped classroom. Thus, all students automatically passed this learning experience. A data triangulation consisting of surveys with open-ended questions, interviews with students and an analysis of the Moodle forums constituted the basis for the evaluation of the Flipped-Classroom Prototype. To gain data for the survey, it was important that students completed a survey. Therefore, the students could gain 5 extra credit points on top of the exam credit points by participating in the evaluation process.

Overall, the evaluation aims at gaining valuable insights on the Flipped-Classroom Prototype in practical use in general and with regard to overcome the lack of interaction, as well as research findings on the conditions of PL in large classes. Consequently, the focus of the evaluation is to gather explorative insights. Therefore, I use qualitative data to gain insights in the intended topics. The qualitative data collection aims at exploring the world from the perspective of the actors involved in their daily lives (Rosenthal 2005; Kohlbacher 2006). In order to derive initial findings and recommendations for action from the Flipped-Classroom Prototype, the data collection includes a survey of free text questions at two measurement points of time during the semester, an interview phase after the exam, as well as the analysis of the contributions to the LMS during the peer-learning phase (see Figure 14).

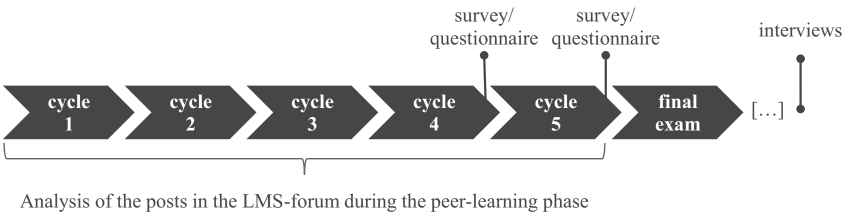


Figure 14: Data Triangulation (Points of Data Collection)
Source: based on Oeste et al. (2015b)

The data from the data triangulation constitute the qualitative data basis illustrated in Table 24:

Type of Qualitative Data	Number of Data Collection	N
Posts of the LMS-forum during phase 3 - PL	6	12 subgroups
Survey (open-ended question student answers)	2	89 participants
Semi-structured interviews with students	-	3

Table 24: Data Triangulation (Data Basis)
Source: own illustration

4.7.2 Qualitative Content Analysis

To analyze the qualitative data I follow a structured content analysis (Mayring 2004; Kohlbacher 2006). Using an inductive approach allows that findings emerge from social reality. This approach is exploratory and requires openness towards new insights

(Kohlbacher 2006). In this context, environments are described from the inside out in order to create an understanding of social reality, according to Flick et al. (2004). The data analysis aims at the generation of insights on the impression, behavior, and motivation of the learners as well as the formulation of recommendations for action for a sustainable establishment of the Flipped-Classroom Concept. The learner-centered data collection helps to analyze the learning behavior and motivation in terms of interactivity and PL conditions. Consequently, the interviews, surveys, and response patterns regarding the LMS forum contributions constitute a data triangulation. The entire data are available in text form. The open-ended questions from the surveys were extracted; the forum posts from Moodle were exported and summarized in a short log. The interviews were first recorded with a voice recorder and then transcribed.

The data were analyzed and evaluated by means of the text analysis software ATLAS.ti, in whose course a category system (see Figure 16) was developed. The inductive development of the category system took place in accordance to Kohlbacher (2006) (see Figure 15).

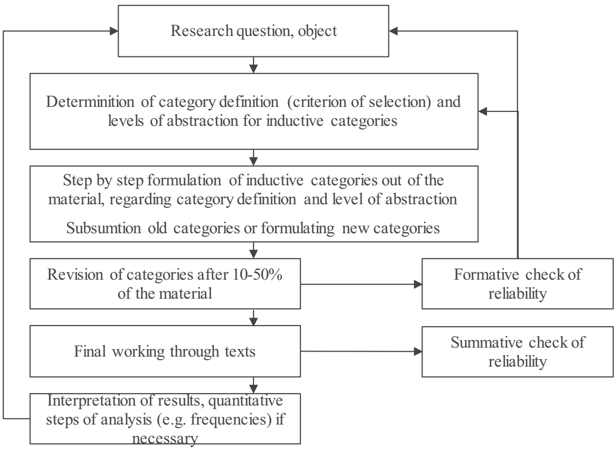


Figure 15: Inductive Category Development
Source: Kohlbacher (2006)

To investigate findings toward the new teaching-learning concept, the category system (see Figure 16) refers to its format and more specifically to the teaching-learning cycle. Therefore, the category system comprises five main categories that reflect the teaching-learning concept of the flipped classroom in general as well as the four phases of the teaching-learning cycle. Additional subcategories emerged from the data as part of the qualitative analysis, inter alia, in the second category of the peer-learning phase. In total the category system has 12 categories.

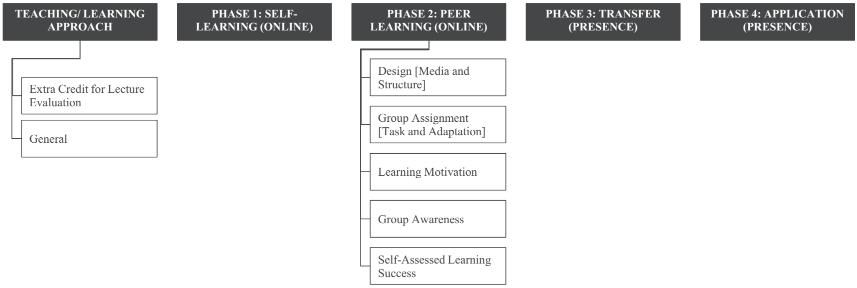


Figure 16: **Category System of the Qualitative Content Analysis**
Source: based on Oeste et al. (2015b)

The structured content analysis according to Mayring (2004) was used as analysis technique. To ensure traceability, a coding guideline with anchor examples and coding rules was developed (Mayring 2004; Kohlbacher 2006). Table 25 illustrates the coding guideline and describes the categories and provides anchor examples.

Category	Definition	Anchor example
(1) Teaching / Learning Approach		
Extra Credit for Lecture Evaluation	Statements/ codes that refer to the procedures and experiences for attending the evaluation of the teaching-learning format.	*Selbstverständlich freut sich jeder über die Bonuspunkte, die man durch die Teilnahme an Evaluationen erhalten kann. Aber es sind eindeutig zu viele Evaluationen.*
General	Statements/ codes that refer to the teaching-learning concept in general and that cannot be attributed to one specific phase of the teaching-learning cycle.	*„Also, an der Vorlesung hat mir ganz gut gefallen, dass man viele Sachen diskutieren konnte. Weil das nicht eine normale Vorlesung war, wo der Professor, sage ich jetzt mal, den Stoff so runter erzählt, sondern man konnte gut diskutieren und seine eigene Meinung äußern. Und das fand ich ziemlich gut.“*

(2) Phase 1: Self-Learning (online)	Statements/ codes that refer to the experiences for completing phase 1.	Durch die Folien und die anderen Videos fand ich das eigentlich nicht schlecht. So etwas finde ich ist immer ganz gut. Auch nur, um den Stoff nochmal durchgehen und verinnerlichen zu können. Das fand ich schon ganz gut.
(3) Phase 2: Peer Learning (Online)		
Design (Media and Structure)	Statements/ codes that refer to the experiences for completing phase 2 with regard to the open conditions for collaborating with other learners.	*Aber Gruppenarbeit mit diesen ganzen Foren - ich habe da keinen Überblick gehabt.*
Group Assignment (Task and Adaptation)	Statements/ codes that refer to the experiences for completing phase 2 with regard to the assignments and its difficulty.	*Manchmal waren da wirklich so Aufgaben, die man nicht in dem Skript findet.*
Learning Motivation	Statements/ codes that refer to the experiences for completing phase 2 with regard to the own motivation for participating to phase 2 as well as the experienced behavior of other learners.	*Evtl. eine Kontrollmöglichkeit für die Mitarbeit in den Gruppen suchen, um bessere Mitarbeit zu erreichen.*
Group Awareness	Statements/ codes that refer to the experiences for completing phase 2 with regard to the awareness of being part of a group of other learners.	*Es ist halt immer schwierig, wenn man die Leute erst mal nicht kennt.*
Self-Assessed Learning Success	Statements/ codes that refer to the experiences for completing phase 2 with regard to the own experienced learning success.	*Man konnte mit einer Gruppe zusammenarbeiten und sich gegen-seitig unterstützen. Man konnte andere Kommilitonen kritisch beurteilen, was mir auch für andere Veranstaltungen helfen wird.*
(4) Phase 3: Transfer (Presence)	Statements/ codes that refer to the experiences for completing phase 3.	*Weil man wie gesagt auch nochmal mit dem Stoff in Verbindung gebracht werden konnte. Und wie gesagt, Diskussionen fand ich auch sehr gut.*
(5) Phase 4: Application (Presence)	Statements/ codes that refer to the experiences for completing phase 4.	*Und ich hatte das Gefühl, dass im Tutorium immer mal auch andere Menschen kamen.*

Table 25: Coding Guideline
Source: own illustration

As a result, the categories were assigned to matching text passages from the data acquisition. In total, 12 categories were assigned to 101 text modules. Based on this, the categories including the assigned text modules were extracted from ATLAS.ti and transferred into evaluation tables. Subsequently, generalizations were derived for each of the 12 evaluation tables for each text module, which were merged into one reduction. Thus, each reduction summarizes the generalizations of a holistic statement of the according category. This way, a compression of the material was produced while forming a cross-section through the material.

4.7.3 Results

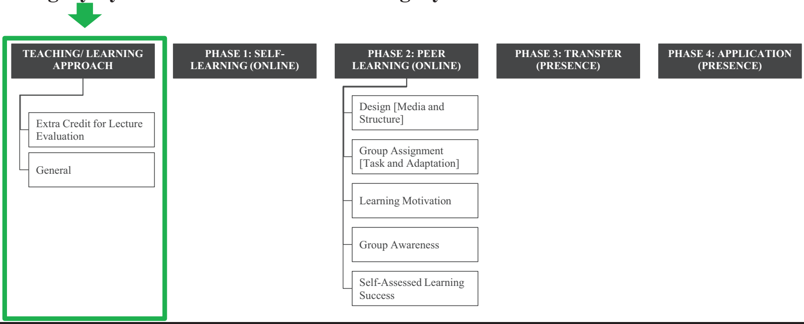
In this section I describe the results of the content analysis along the categories. To describe the results in a meaningful manner, I use tables to illustrate an abstract summary of each main category as well as to interpret the summary and derive recommendations. The tables are structured as follows:

- The line *summary* neutrally addresses the result of the content analysis for its corresponding category.
- The line *quotes* supports the summary with relevant quotes (anchor examples) from the data acquisition.
- The line *interpretation* reflects the interpretation of and findings from the summary.
- The line *recommendation for action* elaborates on the interpretation and formulates practical implications for the effective use of the Flipped-Classroom Concept.

4.7.3.1 Category – Teaching Learning Approach

Table 26 reports the results of the structured content analysis for the first main category. The category refers to the teaching-learning concept of the flipped classroom in general.

Category System and Current Main Category



Category I.1 - Teaching/Learning Approach (General)

Summary	Learners perceive the flipped classroom with an extensive media input as valuable, interesting, meaningful, and sustainable compared to other traditional lectures. They are supported in their learning process as well as encouraged to timely and intensively deal with the learning contents; they can express their opinions and still have enough flexibility to maintain the self-study. The learners perceive the time expenditure of the teaching-learning concept of the flipped classroom as negative.
Quotes	*“This approach definitely makes more sense than mindless memorizing!” […] “I especially liked that you could really get into the learning contents.”*
Interpretation	Learning contents and pedagogical approach of the flipped classroom are mostly perceived as positive. The time expenditure for learners to follow the approach might be too intense.
Recommendation for action	Flipped-Classroom Concept is viable and can be used in teaching. Critical examination of the scope of the learning content and the assignments should be a highly important part of the lecture design.

Category I.2 - Teaching/Learning Approach (Extra Credit for Lecture Evaluation)

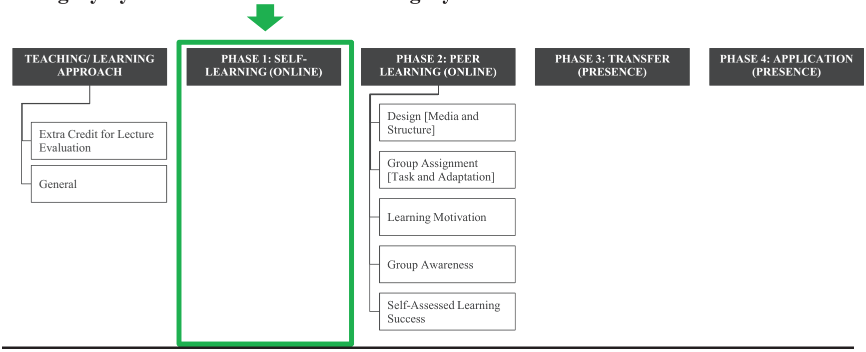
Summary	Learners do not understand the purpose of the evaluation or award of extra credit, which in turn leads to distraction from the actual learning contents.
Quotes	*“And I actually put more focus on the evaluation. That was like the main thing.”*
Interpretation	Learners are confused by lecture evaluations awarded with extra credit.
Recommendation for action	Evaluations with learners regarding the teaching-learning concept are possible. However, the following should be noted: The term “evaluation” should not be communicated. Learners will think that they are the ones to be evaluated. Comprehensible, explicit, and continuous communication of the scoring system concerning credit points and extra credit is a requirement for passing the class – e.g., by means of activating a pop-up when logging in on Moodle or providing FAQ slides.

Table 26: Content Analysis Results for Category I - Teaching Approach
Source: based on Oeste et al. (2015b)

4.7.3.2 Category – Phase 1: Self-Learning (Online)

Table 27 reports the results of the structured content analysis for the second main category. The category refers to the phase 1 of the teaching-learning cycle of the flipped classroom.

Category System and Current Main Category



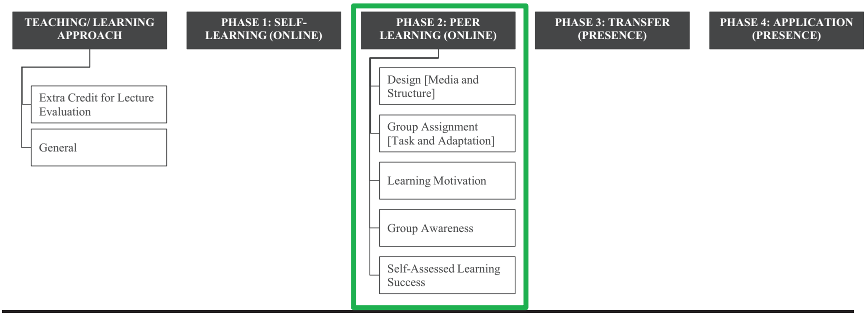
Category II - Phase 1: Self-Learning (Online)	
Summary	Videos are perceived as positive by the learners and allow for flexibility due to the repeatability of learning contents.
Quotes	“Independent acquisition of the learning contents through videos. Therefore, no dry in-class lecture anymore.” […] “That’s always good I think. Also, being able to repeat and take in the material. I thought that was pretty good.”
Interpretation	Transfer of factual knowledge via instructional videos as self-study works.
Recommendation for action	- Instructional videos should only transfer factual knowledge and knowledge on low levels of educational objectives. - Align scope and learning contents of instructional videos with low educational objectives and do not exceed duration of 10 to 20 minutes.

Table 27: Content Analysis Results for Category II - Phase 1: Self-Learning
Source: based on Oeste et al. (2015b)

4.7.3.3 Category – Phase 2: Peer Learning (Online)

Table 28 reports the results of the structured content analysis for the third main category. The category refers to the phase 2 of the teaching-learning cycle of the flipped classroom.

Category System and Current Main Category



Category III.1 - Phase 2: Peer Learning (Design)

Summary

Learners perceive the technical requirements of Moodle as difficult and the structure of the lecture as confusing due to the interlocking of group assignments and forums. As a result, they do not understand the purpose and focus on trivialities.

Quotes

"Well, to be honest, the whole Moodle thing was always a little complicated." […] "And I didn't really come to terms with the system."

Interpretation

The appropriate functionality of Moodle features needs to be explained to learners. Similarly, group activities on Moodle need to be structured clearly and need not to be interlocked.

Recommendation for action

- The lecturer should give a short introduction to the functionalities of Moodle. He should explain the different features and options to interact with Moodle and with other learners to solve the open-ended assignments.
- Options to give an introduction to the functionalities of Moodle:
  - The lecturer demonstrates a live walkthrough of Moodle in the lecture hall during the transfer phase.
  - The lecturer creates a short walkthrough video in form of a screencast that illustrates and explains all functionalities. The lecturer provides access to the video in Moodle.

Category III.2 - Phase 2: Peer Learning (Group Assignment)

Summary

Learners perceive the open-ended assignments as positive, but not as difficult. They demand clearly formulated assignments and case studies instead of theoretical tasks. Learners would be more involved in their group work if they were unable to find a solution on their own. Learners catch up on their group and the assignment. The assignments are often solved individually because the group lacks awareness of each other and interaction. Usually, only few learners upload complete solutions to the forum. Learners experience freeriding of other learners.

Quotes

"The assignments themselves weren't actually too complicated." […] "If you find a question too complex you think – ok, I'll better work this through with the group."

Interpretation	More difficult open-ended assignments motivate learners to engage in group work. Simple assignments are rather solved individually and the solutions are rarely uploaded. There is only little exchange among learners and a low level of interaction.
Recommenda-tion for action	- Lecturers should develop difficult and complex open-ended assignments in the form of practical case studies that "force" the learners to collaborate with each other. The assignments should have a difficulty that is hard to solve individually. - Lecturers should continuously communicate expectations concerning the group work and peer creation of a solution.

Category III.3 - Phase 2: Peer Learning (Learning Motivation)	
Summary	Linking extra credit to group work and assignments would enhance the motivation. The motivation drops when learners feel as if they are doing work for others.
Quotes	*"[…] finding a way to control the group work in order to achieve better group participation" […] "I might have just spared the others their work."*
Interpretation	Learners do not realize the additional benefit of group work to achieve HLL effects. Instead they focus on trivialities such as extra credit and freeriding of other learners.
Recommenda-tion for action	The lecturer should communicate that learners will have an additional benefit that is inherent in HLL effects while training the learning content. Options to communicate the benefit: - Lecturer makes posts in the group forums. - Lecturer sends personal message to all learners via Moodle.

Category III.4 - Phase 2: Peer Learning (Group Awareness)	
Summary	Learners do not dare to actively participate in the group forum. They are afraid of little group discussion and anonymity. Due to the anonymity, the learners do not know each other and think it to be difficult to get in touch with other learners. Learners demand to be introduced to each other during the tutorial. Learners perceive Moodle as a communication platform for learner-lecturer interaction and therefore prefer Facebook for learner-learner interaction.
Quotes	*"It's difficult to compete against something like Facebook." […] "I guess it's always difficult if you don't know the people at first."*
Interpretation	Anonymity in the form that learners did not meet other teammates before, constitutes a great inhibition for learners to invent ad-hoc collaboration and to post solutions in the forum. This causes little interaction and creates a feeling of fear and selfishness. The anonymity must be reduced particularly at the beginning in order to encourage interaction among learners. Moodle needs to be established as a communication platform for learner-learner interaction.

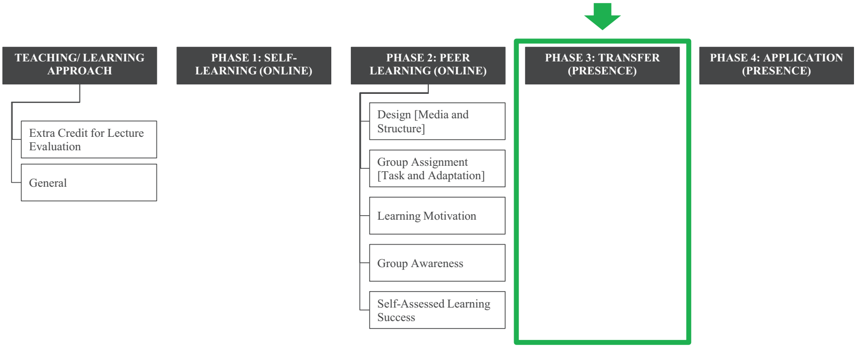
Recommendation for action	Lecturers should reduce anonymity and fears by means of face-to-face contact and establish Moodle as a communication platform for learner-learner interaction. Options are: - First, initiate an introduction round during the transfer phase: e.g., prompt each subgroup to get together in one row and then to introduce each other. - Then, initiate a more intense get together during the application phase (tutorial) to generate group awareness. In this context, expectations for the group work should be identified and communicated by each subgroup e.g., by means of writing down expectations on index cards that are first pinned to a board, and then discussed and summarized into double draws. This way, learners create self-formulated "group rules", that can be posted in the forum as a group's mission statement.
Category III.5 - Phase 2: Peer Learning (Self-Assessed Learning Success)	
Summary	There are learners who assess their learning success to be low, whereas other learners perceive an improvement concerning their reflection, social, and evaluation skills, as well as a more profound understanding of the contents and a benefit from the interaction with others.
Quotes	*"It wasn't like we had to do only group work you had to first get into the topic by yourself. I think that's important for the learning process. So you don't just copy someone else's answers." [...] "Very helpful concerning reflection, social and evaluation skills."*
Interpretation	Learners assess a higher learning success if they actively participate and get involved in the group work.
Recommendation for action	Development of open-ended assignments only solvable by means of group work and interaction. Identification of interaction points that force the learners to reflect acquired knowledge and to interact with others.

Table 28: Content Analysis Results for Category III - Phase 2: Peer Learning
Source: based on Oeste et al. (2015b)

4.7.3.4 Category – Phase 3: Transfer Phase (Presence)

Table 29 reports the results of the structured content analysis for the fourth main category. The category refers to the phase 3 of the teaching-learning cycle of the flipped classroom.

Category System and Current Main Category



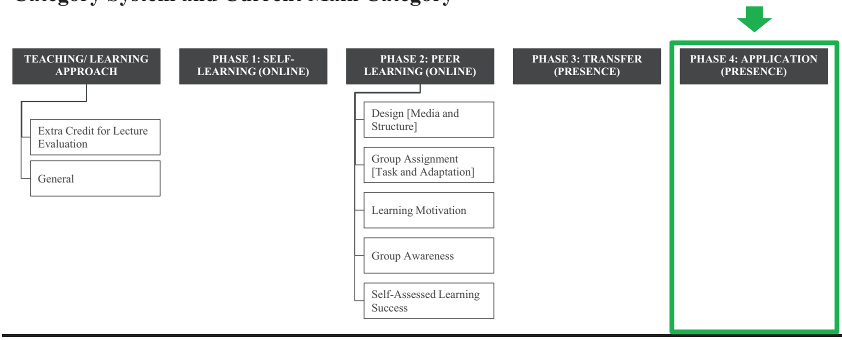
Category IV - Phase 3: Transfer (Presence)	
Summary	Learners appreciate the lecture because of the chance to discuss and repeat learning contents. However, they miss a model solution at the end of the lecture and a brief summary as well as take-home messages. They also wish to get more instructions for the group work.
Quotes	*"Provide a brief summary and a take-home message about what's important to remember at the end of the lecture. That always seems to help when to reflect on the lecture at home." […] "I would have needed an assurance of the results."*
Interpretation	The learners perceive it as valuable to discuss and repeat learning content. It is important to provide learners more guidance for the peer-learning phase.
Recommendation for action	- Lecturers should provide an outlook on upcoming learning contents, expectations, and instructions to help learners to follow the learning activities in the upcoming peer-learning phase. Those instructions should be addressed in the last 10 minutes of the transfer phase. - Contrary to the learner demands, lecturers should not provide model solutions! This is contrary to the intention to reflect learning contents and to activate learners. Furthermore, it would lead to a mere intake of learning contents comparable to a frontal lecture.

Table 29: **Content Analysis Results for Category IV - Phase 3: Transfer**
Source: based on Oeste et al. (2015b)

4.7.3.5 Category – Phase 4: Application Phase (Presence)

Table 30 reports the results of the structured content analysis for the fourth main category. The category refers to the phase 4 of the teaching-learning cycle of the flipped classroom.

Category System and Current Main Category



Category V - Phase 4: Application (Presence)	
Summary	Learners demand a space to get to know each other and to get to know who is in their group during the tutorial.
Quotes	*"It would've been better for me if we could've gotten to know each other during the tutorial."*
Interpretation	Learners appreciate and demand personal contact to other learners.
Recommendation for action	Student assistants should arrange 30 to 60 minutes to get to know each other during the tutorial or set up an extra meeting.

Table 30: Content Analysis Results for Category V - Phase 4: Application
Source: based on Oeste et al. (2015b)

4.8 Discussion, Recommendations for Action, and Future Research

The design goal of the study is to develop a flipped-classroom-concept for large-classes that – (1) overcomes the lack of interaction; and (2) provides the conditions for implementing PL – to allow training HLL. Therefore I discuss in the subsequent subsections the results from the study with regard to the both design goals and with a critical examination of IT tool support, and then summarize the most important recommendations for action in order to apply the Flipped-Classroom Concept. In each subsection I additionally describe future research directions.

4.8.1 DG 1 – Overcome the Lack of Interaction

The main concern of the Flipped-Classroom Concept is to address interaction in all its forms. For this purpose, the generalizable requirements address each of the interaction forms and are respected in the design principles. The design principles base on insights from PL and thus, represent pedagogical guidance. The Flipped-Classroom Concept comprises of a teaching-learning cycle. Each phase of the teaching-learning cycle refers to the design principles. From that point of view, the Flipped-Classroom Concept meets the demand of DG 1 and overcomes the lack of interaction. Learners start in phase 1 with an intensive learner-content interaction. They move to phase 2 and start an intensive learner-learner interaction. This allows them to start in phase 3 in the learner-lecturer interaction with a sophisticated understanding of learning contents. This way, the Flipped-Classroom Concept opens space for different forms of interaction before the presence time in the lecture hall with the lecturer. This way, the several phases of the Flipped-Classroom Concept help learners to improve factual knowledge, procedural knowledge, as well as soft skills. Through the different forms of interaction and especially the learner-learner interaction in phase 2 that demands collaborative activities among learners, learners become able to improve competences of *negotiating*, *persuasion*, *organization, problem-solving*, *leadership*, *communication, teamwork, critical thinking* and *reflection* as well as *self-regulated learning*. This is highly important to turn the transfer phase 3 into a phase of extensive interaction between learners and lecturer (Kim/Kim/Getman 2014). The learners achieve in the two phases before a deep and sophisticated understanding of the learning contents and use the valuable and limited time with the lecturer for clarification questions on the upper levels of Bloom's revised taxonomy.

The evaluation of the exemplary instance of the Flipped-Classroom Concept, the Flipped-Classroom Prototype, manifests that all interaction types in a large class setting become addressed and learners are able to complete each phase of the teaching-learning cycle. Furthermore, it manifests that PL activities that demand intensive learner-learner interaction are even suitable for large classes and enable an activation of learners. However, the findings from the implementation as well as further research results (Strayer 2012; Kim/Kim/Getman 2014) show that the preparation is not perceived similarly by all learners. This still causes a lack of interaction during the peer-learning and transfer phases and demands for future research:

- *To motivate learners, it might help to provide incentives to the learners in order to stimulate them to prepare the learning contents for the transfer phase 3. Therefore, future research should address mechanisms for incentivizing the learners as well as the communication of an individual benefit in the learning process.*

- *Besides that, there are still some learners that do not understand how they will benefit from all the different learning activities in the four phases. A reason might be that the learners are overstrained with the different activities. Therefore, it is important to analyze the things that should be communicated to the learners with respect to the best time 'when', the appropriate way 'how' and the explicit* *communication of the additional benefit and its expectations to achieve it 'what'. The Yield Shift Theory of Satisfaction (Briggs/Reinig/de Vreede 2008) might be a starting point to analyze the learner behavior in order to stimulate learners in preparing learning content.*

4.8.2 DG 2 – Provide the Conditions for Peer Learning

With regard to the several phases of the teaching-learning cycle, each phase has pedagogical guidance from PL insights. However, the most critical phase that specifically addresses PL is phase 2. With the teaching-learning cycle and especially phase 2, the Flipped-Classroom Concept creates the conditions for PL activities in large classes. For this purpose phase 2 creates small-group conditions to integrate constructivist driven PL activities that do not restrict learners in experiencing their environment. Phase 2 helps learners to get in touch with other learners to discuss and to reflect learning content in order to achieve HLL effects. Those activities have to take place before the presence time in the classroom for several reasons: *First*, the results from the PL activities serve as necessary preparation and input for the discussions in the lecture hall; *Second*, PL activities require collaboration in smaller groups. In a lecture hall, it would not be possible to divide learners in small groups and to prompt them to discuss with each other. This would result in chaos. Therefore phase 2 creates space for small group collaboration that is independent from time and place; *Third*, from a constructivist point of view, learners should not be restricted in their learning experience. Therefore the learners work independent from the lecturer in phase 2 as far as possible.

Even though the evaluation of the exemplary instance of the Flipped-Classroom Prototype shows sufficient learner activities and results in the phase 2 'peer learning', there are some constraints. There are still learners that do not engage in the PL activities and take the results that their teammates created without giving any input. In some groups there are more interactions among the learners than in others. Thus, there is a problem of freeriding and missing team spirit. To overcome these problems reorganized personal rounds of introductions and expectation questionnaires in presence might be suitable in this context. Besides that, the PL activities are asynchronous. This seems to stop learners in their interactions among each other, and learners start with solving the assignment again and again. These insights provide important starting points for future research:

The results from evaluating the Flipped-Classroom Prototype show, that PL activities can be enhanced in large classes. It is important to create open-ended assignments that refer to the upper levels of Bloom's revised taxonomy. Furthermore, it is necessary to initiate IT-supported subgroups in which PL activities should take place. IT-support helps to cope with large class sizes and allows lecturers to observe the activities. However, asynchrony, anonymity, and less guidance seem to be difficult for learners to follow. Even though constructivism posits that learners should not be restricted in their learning experience, it might be a solution to provide them more guidance. This leads to research questions that should analyze how to systematically design PL activities in a reusable way to achieve HLL effects and learner engagement.

4.8.3 IT Support in the Flipped-Classroom Concept

Another important aspect is the necessary IT support that supports the teaching-learning process in the flipped classroom. Extensive IT support allows learners to study at their own pace and enables an asynchronous interaction with other learners in the self- and peer learning phases. However, it also requires suitable equipment from the learners. In the present case, the learners had the chance to borrow a tablet or netbook for the duration of the semester. This way it becomes possible that all learners have access to the learning materials and learning activities. However, a suitable broadband connection is required. The entire campus is connected to Wi-Fi. However, there is typically a significant number of commuter learners, who do not always have broadband internet access (Roach 2014).

For this reason, the learning materials in the phases 1 with regard to the instructional videos were made available for download, so that learners could locally save the video during their limited stay on campus. This is closely related to the significant IT support in the teaching-learning process. The correct use initially overstrained learners, e.g., the LMS that supported self- and peer-learning phases. It might be constructive to thoroughly assist the learners at the beginning, e.g., by means of tutorials. This pedagogical concept of scaffolding ensures that learners are thoroughly supported at the beginning of a course, while continuously withdrawing the support during the course progress, allowing the learner to focus on their self-directed learning (Kim/Kim/Getman 2014).

Thus, future research should focus on guidance to use the provided IT support to gain insights in scaffolding.

4.8.4 Recommendations for Action to Use the Flipped-Classroom Concept

All teaching-learning concepts' common dependent variable is learning success, or more precisely expertise increases (see 2.1.4). To take the described aspects into account, the Flipped-Classroom Concept is an innovative approach that addresses both low and high levels of educational objectives, even in large university classes. Additionally, according to service research with its concepts of IT support and customer integration, an extensive transferability of university teaching becomes possible. Teaching generates comprehensive teaching-learning conceptss and accounts for "humanizing" large-scale lectures aside from the much-vaunted MOOCs (Roach 2014). In this way, the Flipped-Classroom Concept enables universities to meet the challenges of high-quality teaching. The Flipped-Classroom Concept gives learners enough time to thoroughly reflect on learning contents while simultaneously leaving sufficient time for the development of valuable skills such as teamwork and communication skills, critical thinking, reflection skills, time management skills, and skills for self-directed learning. Thus, the learners are supported in their personal development, while evolving their personal potential in becoming autonomous cosmopolitans.

For future research it might be interesting to analyze LLL and HLL success effects by examining changes in the level and amount of expertise. Hence, future research should conduct this study as an experimental design with students randomly divided in test and control groups. The findings yielded from an experiment will bring more valid results regarding the effects of the Flipped-Classroom Concept on interaction, learning satisfaction, and learning success.

The Flipped-Classroom Concept has the potential to change common traditional lecture structures and helps universities to provide a high-quality education. On an operational level, universities face challenges to sustainably implement and establish the Flipped-Classroom Concept for different management lectures. This leads to recommendations for action for adapting the Flipped-Classroom Concept in other management classes (see Table 31):

Flipped-Classroom Concept
- It is necessary to examine the scope and amount of the learning content as well as of the open-ended assignments. The reason is that there is a tendency of conveying more learning content to the learners. - The evaluation of the teaching-learning concept of the Flipped-Classroom Concept should be communicated in an understandable manner. There should be a clear focus on the expectations and additional benefit for the learners. Incentives such as extra credit points can support the motivation of the learners.
Phase 1: Self-Learning
- Learning content on low educational objectives that focuses on factual knowledge should only be provided in the learning materials. - Learning videos should have duration between 10 and 20 minutes to allow high flexibility in managing self-directed learning activities. - All learning materials must be provided for download.
Phase 2: Peer Learning
- Learners should receive a short instruction on how to use IT and the LMS (Moodle). - Difficult open-ended assignments should be created by a lecturer as input for the second phase. The assignments should focus on practical case studies with subtasks. The difficulty of the subtasks should demand learners to ask each other questions and justify ones position. - The lecturer should continually communicate the expectations, additional benefit, and process steps for the collaboration. - Anonymity and fear should be reduced by e.g. initiating a face-to-face meeting of each subgroup.
Phase 3: Transfer
- Lecturers should give an outlook on the future learning content and the expectations in the subsequent phases with regard on how to solve the open-ended assignments. - Lecturer should not give a sample solution of assignments to learners.
Phase 4: Application
- A 30-to-60 minute face-to-face meeting should take place in phase 4.

Table 31: **Recommendations for Action to Use the Flipped-Classroom Concept**
Source: own illustration based on Oeste et al. (2015b)

4.9 Limitations, Conclusion, and Contribution

There are, however, several limitations coming with the nature of an explorative research design. Working with students in a real setting within a complex teaching-learning arrangement includes various pedagogical mechanisms. Thus, it is difficult to identify causal relations. Since the data collection was in a real setting, I cannot precisely prove that an increase in interaction, learning satisfaction, and learning success will solely result from the Flipped-Classroom Concept. A field research project is subject to several confounders, so changes in interaction, learning satisfaction, and learning success could also arise from other external effects (Bortz/Döring 2009). The second limitation comes along with the variable of learning success. The learning success is a very complex variable, difficult to measure, and can be affected by various effects – even outside of class (Hölbling/Bohlander/Stößel 2010). Even in terms of using the same exam from a past semester as reference point, it cannot be guaranteed that rating is the same each semester. In line with previous research findings (Bitzer/Janson 2014), I expect that students will receive in follow up experiments better results in the final exam and that they are more satisfied with the teaching method of Flipped-Classroom Concept. In addition, it is expected that the results show, despite the challenges of university large-scale lectures, that learner-centered interaction enriched with peer learning mechanisms as well as time- and resource-saving formative individual learning success verification are possible. However, measuring learning success was not the focus of the current study. In this study I aimed at gaining insights into the two design goals to overcome the lack of interaction and to create the conditions for PL in large class settings.

Therefore, the current study described the development and evaluation of a theory of design and action. Characteristic components are inter alia the Flipped-Classroom Concept as an innovation in teaching; the chapter also provided design principles and implementation guidance for practical use in large university classes. Furthermore, the chapter formulated recommendations for action on the basis of the practical implementation and evaluation in an IS introductory lecture. The Flipped-Classroom Concept as an innovative teaching-learning concept consisting of four IT-supported phases addresses interaction and feedback on the high levels of educational objectives (see Table 32).

	1st Phase	2nd Phase	3rd Phase	4th Phase
				
Goal	Self-directed knowledge acquisition.	Application and transfer of knowledge.	Clarification of peer-created solutions.	Application of knowledge and methods.
Instruc-tions	Work through learning materials and knowledge tests.	Solve free text assignment individually and collaboratively.	Discuss questions and assignment solutions in the lecture hall.	Participate in tutorial and apply your knowledge.
Output	Knowledge gain, same knowledge base.	Peer-created solution of assignment.	Sophisticated understanding of learning content, correct solutions.	Sophisticated understanding and ability to apply knowledge.
Lessons Learned	Knowledge on low educational objectives. Videos for download (videos 10–20 min).	Instructions on how to use IT and LMS. Communicate expectations and benefits. Initiate a space to get to know teammates.	Outlook on future learning content. Lecturer should not give sample solution to learners.	Provide 30–60 min face-to-face meetings.

Table 32: **The Flipped-Classroom Concept in a Nutshell**
Source: own illustration

This teaching innovation empowers universities to mobilize expertise more efficiently. Optimally, learners become prepared for future daily business in innovative organizations. Based on the findings of the Flipped-Classroom Concept in terms of the flipped-classroom prototype, the results indicate an utilizable teaching-learning concept. Besides the intervention of factual knowledge, the different phases of the teaching-learning cycle aim at strengthening specific soft skills: In phase 1 for example, learners can improve competences of confidence, time management, and self-directed learning. They have to manage the acquisition of factual knowledge themselves. Through the collaboration with other learners in phase 2, they have the opportunity to improve their communication and cooperation competences within the teamwork.

Along with DSR the study can be classified as the contribution type 'improvement' and more precisely constitutes a 'theory of design and action'. The results of this chapter are of practical relevance since they illustrate how to time- and resource-efficiently address all three interaction types, enhance collaboration among learners, and integrate direct feedback mechanisms in large classes. The results provide insights on how large classes can be designed in order to overcome the lack of interaction, by incorporating mechanisms of peer learning in a learner-centered teaching. Moreover, the results serve IS lecturers as a practical contribution to face the challenges of large class IS lectures that are coined by limited lecturer time and resources. The results are highly relevant for practitioners who have to face learners' low persistence and high dropout rates, which is the case in traditional large-scale lectures (Garavan et al. 2010b; Jordan 2014).

The study contributes to the body of pedagogical literature on teaching-learning concepts in several ways. Typically a flipped classroom is used for small class sizes. In this study I show how to redesign a large class lecture that meets the benefits of a flipped classroom by using IT support. The redesign serves as a new teaching-learning concept that overcomes the lack of interaction and provides conditions for PL. Moreover, the study contributes to the body of PL literature since it creates conditions for PL in large classes. More precisely the Flipped-Classroom Concept allows integrating PL mechanisms that are driven by constructivism. Those allow learners to experience their environment in order to gain new knowledge. However, the results show that learners seem to be overstrained in their PL activities and demand more guidance in phase 2. Against that background the study opens the set of unsolved problems inherent in systematically designing PL activities.

5 PEER-LEARNING REFERENCE-PROCESS APPROACH (PL-RPA): Engineering Peer- Learning Reference Processes for Generating High-Quality Learning Materials[5]

5.1 Peer-Learning Reference-Process Approach in the Context of the Thesis

In chapter 5 of my thesis I will address my second research question:

> What are conceptual foundations and assumptions to systematically design reference processes for peer learning?
> *(Conceptual foundations)*

Answering RQ 2 creates an understanding of the research assumptions for systematically designing PL activities in order to enhance learning effects in a replicable and transferable manner. Moreover, it derives the conceptual foundations for designing reference processes for PL. The study of the Flipped-Classroom Concept (see chapter 4) provided insights into the application domain of PL and its relevance. The results showed that learners struggle with constructivist PL activities. Not all learners followed the PL activities. There were some learners who felt overstrained with the learning experience; some demanded more guidance; some were distracted by teambuilding activities; and others showed freeride behavior. Therefore, a promising solution seems to be to systematically design PL activities that combine collaboration expertise with pedagogical know-how that should take into account sufficient pedagogical-driven learning tasks.

However, this requires a sophisticated understanding of PL with its constructivist driven foundations and CE as a methodology to systematically design collaborative activities. It is important that designed collaborative PL activities restrict learners in a way that they receive facilitation guidance on how to focus on learning assignments. Learners should also have the freedom to experience their environment. Therefore, in this chapter, I will theory-driven develop the Peer-Learning Reference-Process Approach (PL-RPA) that describes the basic research assumptions about how to systematically design PL activities and about the conceptual foundations for developing reference processes to initiate PL activities for enhancing HLL.

[5] The insights presented in this chapter are based on a publication on this topic: (Oeste/Söllner/Leimeister 2014). Thanks to my collaborators, the reviewers and attendees of the CRIWG 2014 for their valuable feedback on my work.

5.2 Research Approach and Study Outline

The current chapter describes a study with the aim of developing a conceptual design artifact inherent in the PL-RPA. To guide my design choices I ground my research on DSR (Gregor/Hevner 2013). According to the types developed by Gregor and Hevner (Gregor/Hevner 2013), this work constitutes a contribution of the type 'improvement' (classification and description of contribution types see section 3.2.3). More precisely, the prescriptive knowledge contributions are inherent in the following components: I theory-driven propose a *model* that illustrates the research assumptions for peer-learning reference processes. Moreover, I propose a *method* (technique) in the form of the PL-RPA. Both constitute according to (Gregor/Hevner 2013) principles of form and function and thus, illustrate the conceptual design of a generalizable solution. I assume that combining CE mechanisms and PL is an appropriate approach to systematically design reference processes for PL that brings together pedagogical underpinnings and collaboration expertise with facilitation guidance.

To gain insights and to develop the PL-RPA, I focus on working on common material in the form of collaboratively documenting knowledge. The output will be a knowledge document that can be used as high-quality learning material. This demands pedagogical underpinnings with regard to the learning task and a sophisticated understanding of knowledge, meaning the upper levels of Bloom's revised taxonomy, which represent HLL. Against that background I describe a conceptual study that contributes to the body of literature as follows. The study provides the basics and the starting point to systematically design reference processes for PL. To develop the PL-RPA I first provide a brief description of the theoretical basics of PL and CE in section 5.4. This serves as a basis to theory-driven conceptualize the PL-RPA in section 5.5. In section 5.5.1 I describe the research assumptions and summarize them in a model. I describe the PL-RPA as a technique for designing reference processes for PL in section 5.5.2. In section 5.6, I summarize the findings and give an outlook on the next steps for future research with regard to the structure of my thesis.

5.3 Problem Statement and Design Goal

With regard to organizations that struggle with knowledge losses as a consequence of job rotation and retiring experts as well as universities that have to provide high-quality education, PL and thus, knowledge transfer is highly important. Typically, there are less experienced and more experienced people that work together or receive the same learning experience. Therefore, it is vital to satisfy the demands of all learners. Collaboration research shows that heterogeneous groups – e.g., with less experienced and more experienced learners – can achieve a gain in productivity (Ries et al. 2013; Bittner/Leimeister 2014). Thus, heterogeneity should not be treated as a disadvantage. Against that background, mechanisms for collaborative knowledge generation become important (Fuchs-Kittowski 2013). In this context PL and PC have the potential to enable the integration of learners with the help of creative PL activities and to empower learner to be producers of learning content instead of just being consumers (Johnson et al. 2014). When it comes to enabling knowledge transfer, the challenge lies in empowering learners to codify and document knowledge in a way that the resulting knowledge documentations can be used by other learners as the basis for knowledge acquisition. This is challenging for several reasons. To codify knowledge in an understandable manner a sophisticated understanding of the knowledge and its related knowledge concept is needed. So, the involved learners that document the knowledge will need to discuss the knowledge, explain their understanding to each other and challenge positions. This constitutes a complex and constantly recurring task that demands for a reference process in order to make those PL activities reusable and transferable. CE research already provides useful mechanisms to systematically design collaborative activities in a reusable manner. However, pedagogical guidance is necessary to cope with the demands from PL. To use CE mechanisms and to respect pedagogical guidance with regard to learning task and PL activities constitutes a new research approach.

Knowledge transfer from less experienced people to experienced people is still a challenge that both organizations and large university classes face. While organizations need to avoid the loss of knowledge because of retiring experts, large university classes need to provide high-quality education that addresses less experienced and experienced learners at the same time. Knowledge transfer between learners has the potential to enable PL activities for achieving HLL effects, since the involved individuals will benefit and learn from the interactions among each other. Therefore, a possible way to cope with the demand described above is to have learners develop an output together, e.g., in the form of learning materials for their own or for third parties. Based on insights from both pedagogical peer learning and collaboration research a PL-RPA seems to be a promising approach to derive the conceptual foundations to systematically design PL activities in the form of reference processes due to several reasons:

- PL reference processes provide learners with facilitation guidance on how to enhance knowledge acquisition, including transfer as well as documentation. They differentiate between *input* in the form of learners or lecturers, and a well prepared pedagogical learning task; a *throughput*, that comprises the sequence of PL activities bringing together collaboration expertise; and an *output* in the form of material developed together. They provide the potential to enable lecturers (or other practitioners) to conduct and implement those reference processes without collaboration expertise to stimulate PL effects for HLL.

Collaboratively developing learning materials with learners helps to codify and understand tacit knowledge. Collaboration has the potential to create learning effects even among learners and to help learners to increase their knowledge base. Besides that, the output in the form of learning material developed together might have a better quality since it represents the results of sophisticated collaboration between learners.

Therefore, the design goal of this study is:

- *Design Goal 1: Develop an approach that creates an understanding to systematically design PL activities to enhance learning effects in a replicable and transferable manner.*

5.4 Theoretical Background

5.4.1 Related Work in Peer Learning

Following the assumption that knowledge documentation in the form of developing learning material provokes a learning process, makes pedagogical basics necessary. Learning is characterized by changes in behavior that result from experiences (Gagné 1984) like conversations and discussions (Wegener/Leimeister 2012). Humans learn on the basis of their own experiences and connect those with previous knowledge. In this context, PL provides suitable mechanisms that represent this position of learning. A group of people learn or attempt to learn something together through social interactions (Dillenbourg 1999). Interactions like discussions with other learners, called peers, foster to reflect knowledge and to stimulate cognitive processes that enable learning effects in the form of expertise increases (Arbaugh 2010). This has positive effects for the learner: e.g., knowledge gains; an improvement of communication skills; and responsibility for own activities (Damon 1984; Geer et al. 1998; Topping 2005; Wegener/Leimeister 2012).

In addition PL focuses on the learner and permits interactions between learners on the same level of knowledge (Geer et al. 1998; Hua Liu/Matthews 2005a). In most cases a lecturer prepares the learning experience and assists the learners in their learning experience (Harris 1998).

Table 33 shows the concept of PL and related forms that provide insights on PL. In that context, PC provides mechanisms for LM development. The idea of PC is that the output from the PC activities can be used by an extended group of people. PC comprises mechanisms of co-creation (Wegener/Leimeister 2012) which indicate first insights on how people collaboratively create knowledge documentations. The learners add value to the LM. They reflect, discuss and document their own knowledge in a way that it represents a structured description of knowledge concepts that can be used as high-quality learning content (Wegener/Leimeister 2012). Until now, structure and learning objectives are open or predetermined by the lecturer (Auvinen 2009). Only small PC tasks are addressed such as to generate a multiple-choice task. This typically refers to the lower levels of Bloom's revised taxonomy and does not cover HLL. Further, the LM development is not reusable, since PC follows constructivist learning theories. Therefore the learners are free in their activities and there is only little guidance that restricts the learners in their learning experience (Wegener/Leimeister 2012). To develop LM that enables HLL, Wegener and Leimeister (2012) identified key principles as shown in Table 33. Those key principles offer first insights on how to design processes that support learners in documenting knowledge. However, to develop such PL activities in a reusable manner often depends on the specific learning content and context. As a consequence, reproducibility and assignability are still an unsolved problem (Kollar/Fischer/Hesse 2006).

	Goal	Audience	Group Size	Type of task	Principles
Peer Learning	Learning from and with others.	Learner (peer) Instructor	Groups of 2 – 6 people up to >100 people	Not specified.	- Social interaction (e.g. discussion). - Stimulate reflection of knowledge. - Enhance cognitive processes for HLL.
Peer Tutoring	Practice learning content and basic skills.	Learner (tutee, tutor) Instructor	Dyads	Strong structure.	- Learning tasks are not completely new. - Well-experienced learners assist less-experienced learners. - Learners change the role of tutor and tutee after a defined time. - Learners solve learning tasks together.
Cooperative Learning	Learners receive a problem situation (subtasks) and develop a solution.	Learner (peer) Instructor	Small groups with 3–6 people	Subtasks that build up on each other.	- Positive interdependence between subtasks. - Face-to-face communication and reciprocal interactions. - Individual accountability for learning activities. - Reflection and discussion of knowledge concepts in group processes.
Peer Creation	Learning material development from peers for other peers.	Learner (peer) Instructor	Peer develops material alone or with another peer.	Learning material development (e.g. multiple-choice tasks).	- Clear instructions to solve the task (e.g. create a multiple-choice task for ERM modeling). - Peers are accountable for developed learning material. - Peers have expert knowledge and thus, are able to cope with learning task. - Peers receive training on basic pedagogical concepts. - Peer interaction and peer discussion are basic requirements that help to ensure a high-quality output.

Table 33: **Classification of Peer Learning Concepts**
Source: Oeste et al. (2014) adapted from Topping (2005); Büttner/Warwas/Adl-Amini (2012); Wegener/Leimeister (2012)

5.4.2 Related Work in Collaboration Engineering

Collaboration is the work of two or more people on common material, which is characterized by coordination, communication and cooperation (Leimeister 2014). CE research provides an approach for designing and conducting collaborative processes to solve complex and recurring tasks. The more often a task occurs, the more efficient it is to develop a reusable process design to support and guide collaborative activities and thus, to solve the task with the same process flow. In this context, a group of people works together towards a common goal while group activities are characterized by communication, cooperation and coordination (Kolfschoten/de Vreede 2009a; Leimeister 2014). These structured activities support collaboration and thus, lead towards an additional benefit that cannot be attained by individual endeavor (Bittner/Leimeister 2014). CE differentiates between three roles (see section 2.2.2). A *collaboration engineer* designs and documents a collaborative process. A *facilitator* is able to design a non-recurring collaborative process and disposes expert knowledge and moderation skills, so that he is able to conduct a process. A *practitioner* can act as facilitator or as participant of a collaborative process and is an expert on task and owns expert knowledge. The *layer model of collaboration* provides a framework to systematically design collaborative processes (Briggs et al. 2009). The layers are hierarchical and depend on each other (see section 2.2.3): Goals as the first layer focus on defining a desired state or outcome as a group goal (Briggs et al. 2009; Briggs et al. 2014a). The product layer addresses tangible or intangible artifacts as the outcome produced by a group. Defining and acquiring sub products in a collaborative process leads to one common product (Briggs et al. 2009; Briggs et al. 2014a). Activities as the next layer describe particular subtasks a group must do to achieve defined products to fulfill the common goal (Briggs et al. 2009; Briggs et al. 2014a). The subsequent layer addresses procedures. These are methods, strategies, and tactics a group uses to execute work. So-called patterns of collaboration – generate, reduce, clarify, organize, evaluate, and build consensus – characterize how activities become structured and are observable regularities for the defined activities (Briggs et al. 2009; Briggs et al. 2014a). The next layer refers to tools and describes several technologies to support the execution of the collaborative process (Briggs et al. 2009; Briggs et al. 2014a). Scripts as the last layer address documentation of behavior people say and do as they collaborate (Briggs et al. 2009; Briggs et al. 2014a).

In the context of the set of unsolved problems inherent in systematically designing reference processes for PL the concept of CE provides useful guidelines. The knowledge transfer with its documentation of knowledge in the form of learning materials constitutes a complex task, and thus, falls into the scope of CE. Nevertheless pedagogical claims are not anchored in CE so far. Against that background, I illustrate in the subsequent sections how to connect PL with its pedagogical underpinnings and CE as a methodology to systematically design collaboration among people.

5.5 The Peer-Learning Reference-Process Approach

5.5.1 Guiding Idea for Peer-Learning Reference Processes

Based on the benefits of PL and CE I develop the idea for peer-learning reference processes in order to enable a knowledge transfer by working on a common outcome – e.g. documenting knowledge in the form of LM. The knowledge documentation is more or less a functional instrument that provides the participants some kind of common material to focus their collaboration towards a common goal and thus, to enable knowledge transfer. For that reason, I propose the following research assumptions:

- *Research assumption 1:* Collaboration, the work of two or more people on common material, enables a focused knowledge transfer among people.

- *Research assumption 2:* Knowledge transfer that is characterized by discussions and interactions among each other triggers among each participant a reflection of knowledge.

- *Research assumption 3:* The reflection of knowledge stimulates cognitive processes for chunking. Thus, each participant builds relationships among existing knowledge concepts or knowledge chunks with new ones. Knowledge frames chunk into larger frames and thus, a learning process occurs.

- *Research assumption 4:* A learning process is the basis for a sophisticated understanding of knowledge concepts. Thus, it constitutes the basis for high-quality documentations of knowledge that are e.g. correct and represent the knowledge in a structured way.

- *Research assumption 5*: The documentation of knowledge comes to an end when the quality of developed LM is high (e.g., knowledge is documented correct, represents all relevant knowledge concepts, and illustrates relationships in a structured way). Otherwise the participants complete again activities for reflection of knowledge, learning process, and documentation of knowledge.

Figure 17 illustrates the research assumptions in the form of a model.

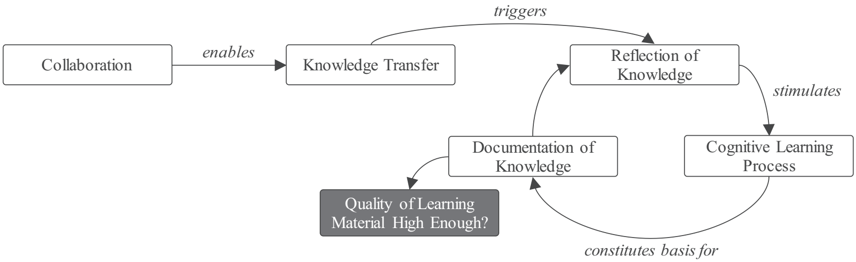


Figure 17: **Model of the Research Research Assumptions for PL-RPA**
Source: based on Oeste et al. (2014)

Thus, solutions become important that enable a collaborative knowledge transfer while helping the participants to expand their knowledge base and document their expert knowledge and know-how in the form of LM. From that point of view CE provides methodologies that are the basis to systematically design peer-learning reference processes, e.g., for collaborative knowledge documentation. Systematically designed collaborative activities have the potential to provide guidance to the learners and help them to focus on their learning experience. Hence, I use methodologies from CE to design PL activities. I connect those methodologies with insights from the body of PL literature to ensure a pedagogical underpinning.

Figure 18 illustrates the guiding idea of peer-learning reference processes. It also opens two different perspectives, which also illustrate entry points for research: (A) the direct scope of peer-learning reference processes with its PL activities among the participants and; (B) the indirect scope of peer-learning reference processes that focuses on the distribution of the developed outcome to an extended group of people, such as LM.

(A) Peer-Learning Reference Processes: The direct scope of peer-learning reference processes focuses on the process itself with the PL activities. Thus I differentiate between input, throughput, and output to explain the intention. The participants in the form of learners (practitioners) typically have a different level and amount of knowledge. Those participants with their knowledge constitute an input. A further input comes from a facilitator (lecturer / practitioner) with moderation skills that prepares a well sufficient pedagogical-driven learning task. He prepares a task for which the participants have to create a solution. The throughput addresses the PL activities themselves and thus, the several steps which the participants have to pass to cope with the task and thus, to create a solution. This way, the throughput represents the design of the before systematically designed PL activities that the participants have to complete.

As a consequence of the reciprocal interactions between the participants, they join in a knowledge transfer, reflect knowledge, activate cognitive processes, and achieve individual knowledge increases. Since the learners work on a common material and develop some kind of outcome, knowledge documentation takes place. The knowledge documentation is instrumental and thus, has two positive effects. As a consequence of the collaboration, the social interactions stimulate cognitive processes to reflect knowledge and to achieve a sophisticated understanding of knowledge. Hence, the knowledge documentations in the form of LM will be of high quality and represent knowledge concepts. Thus, from a pedagogical point of view, cognitive process dimensions like applying, analyzing, evaluating and creating knowledge (Krathwohl 2002) will be addressed. The second positive effect will be inherent in the quality of the knowledge documentation. Since the participants challenge their positions during the discussions with each other, they will develop a sophisticated understanding of the knowledge. Thus, the likelihood that the knowledge documentations are correct and represent structured relationships among knowledge concepts will be high.

(B) Distribution: The indirect scope of peer-learning reference processes focuses on the distribution of the collaborative outcome, e.g. knowledge documentation in the form of LM. An extended group of people can use those LM in order to increase the own knowledge base and thus, to achieve an individual learning success. However, it is expected that this kind of learning will focus more on lower cognitive process dimensions like remembering or understanding (Krathwohl 2002).

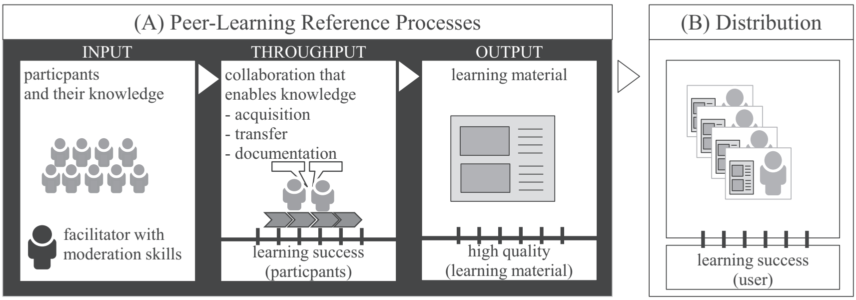


Figure 18: Guiding Idea for Peer-Learning Reference Processes
Source: based on Oeste et al. (2014)

5.5.2 Peer-Learning Reference-Process Approach

In order to design peer-learning reference processes that are reusable and that enable knowledge transfer and documentation by creating content for LM, I develop the PL-RPA. The PL-RPA illustrates requirements from learning literature and CE literature.

Those need to be respected in order to design peer-learning reference processes. Hence, Figure 19 refers to the guiding idea of peer-learning reference processes. It illustrates areas of requirements from learning literature as well as CE with regard to the Six-Layer Model of collaboration.

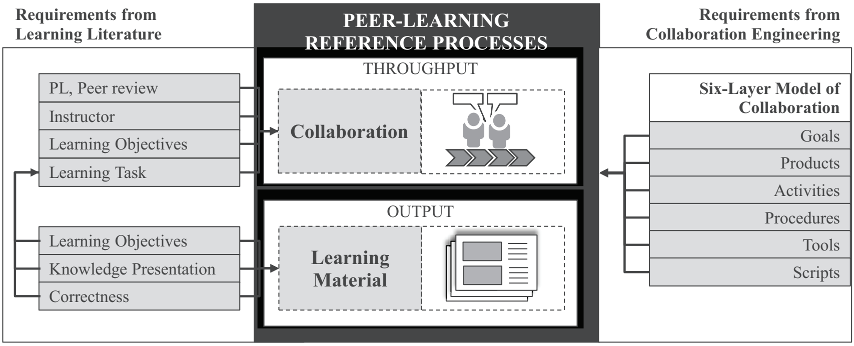


Figure 19: **Peer-Learning Reference-Process Approach**
Source: based on Oeste et al. (2014)

The center of Figure 19 indicates the purpose of peer-learning reference processes and its output. On the left, Figure 19 visualizes requirements from learning literature, while it visualizes in the rights areas of requirements from CE literature.

Areas of Requirements from Learning Literature

To start with the areas of requirements from learning literature, those inter alia PL, PR, learning objectives, and learning task. Those areas of requirements will directly influence the design choices for PL activities. They focus on how the participants have to collaborate. Besides that the figure also visualizes the influence of the type of learning materials. This leads to quality demands that address pedagogical aspects, such as learning objectives, the kind of knowledge presentation and its correctness. With respect to the nature of the outcome, areas of requirements will indirectly influence the design choices for PL activities, too. Those provide important inferences on the learning tasks respectively the way the collaborative goal and product should be achieved – e.g. the collaborative creation and correction of a multiple-choice task as outcome is not as complex as the creation of a teaching-case solution.

In order to design peer-learning reference processes pedagogical guidance is needed. Thus, requirements from PL need to be considered to mediate individual learning success and the development of LM. To derive requirements from PL, I differentiate between the PL activities themselves and the output in the form of LM. It is important two differentiate between those two perspectives for two reasons.

- On the one hand this helps to derive insights for the composition of the PL activities among the learners.
- On the other hand, this helps to guide the design choices with regard to the structure and pedagogical underpinning of the learning task that will inter alia refer to the structure of the outcome of learners collaborative activities.

The PL activities should help the participants to learn something and thus, to gain knowledge. Through social interactions and collaboration with others, they expand their own knowledge base and document exchanged knowledge. Thus, activities for knowledge transfer, acquisition, and creation take place. To focus those PL activities in the intended manner – to help the participants (a) to benefit from the collaboration by expanding their knowledge and, (b) to ensure a high-quality LM that can be used by third parties for knowledge acquisition – insights from *peer review* might be a useful solution. Thus, a preparation of the learning experience is needed. Besides that, *peer learning* requirements such as reciprocity in social interactions as well as direct feedback should be respected (Harris 1998) in the process design. Furthermore, a *lecturer* should prepare the basic conditions for PL, e.g., prepare a learning task, guide participants through their PL activities, and communicate explicit expectations (Harris 1998). To help the participants to expand their knowledge base, pedagogical guidance should be inherent in sufficient learning tasks that e.g. refer to *learning objectives* (Krathwohl 2002). More requirements arise from the intended outcome, and thus from the type of knowledge documentation in the form of *learning material* – e.g. whether the focus will be on factual knowledge that refers to the lower levels of Bloom's revised taxonomy or procedural knowledge that refers to the upper levels of Blooom's revised taxonomy. The creation of a multiple-choice task differs in its complexity from the creation of a teaching-case solution. Consequently, the preparation of the learning task will also be different in order to support the learners in experiencing HLL effects through collaboration among each other. Hence, the need for different designs of peer-learning reference processes arises from the complexity of knowledge.

To focus on the output of peer-learning reference processes, it is important to ensure a high quality. Since an extended group of people should be able to use the outcome to acquire knowledge, the pedagogical underpinnings should be inherent in the outcome, e.g. *learning objectives* (Krathwohl 2002). Furthermore, *knowledge presentation* in an abstract, coherent, and logical way is important to represent the knowledge in its whole complexity. Those indicators of quality arise from the type of LM – a multiple question as LM demands a different quality and level of sophistication in the understanding of knowledge than a learning video as LM. Thus, depending on the type of LM, e.g., textual explanation, a multiple-choice question, or an explanation video, there are different quality indicators for the outcome. Besides the way on how the knowledge is presented, it should be ensured that the knowledge is documented in a *correct* way (Leacock/Nesbit 2007). In order to cope with a high quality of knowledge documentations, controlling mechanisms such as *peer reviews* might be a solution. Therefore, the design of peer-learning reference processes should respect peer-review mechanisms.

Areas of Requirements from Collaboration Engineering Literature

On the right, Figure 19 refers to the Six-Layer Model of collaboration. This illustrates areas of requirements from CE literature. The starting point should be the Six-Layer Model of collaboration with the several layers. In the design of peer-learning reference processes, those areas of requirements are important since they will help to package facilitation guidance and collaboration expertise in the design of peer-learning reference processes.

CE provides a methodology to design collaborative processes among human beings. In that context, the Six-Layer Model (see section 5.4.2) provides a design methodology and illustrates requirements that need to be respected while designing collaborative activities (Briggs et al. 2014a). The idea of CE is to help participants to focus their work on common material towards a common goal without being distracted by other things. A process design is reusable in a way that it leads to predictable and repeatable results. According to the Six-Layer Model of collaboration (Briggs et al. 2014a) all layers will set requirements to design peer-learning reference processes. From a pedagogical point of view, several layers will become important for expanding CE research. A collaboration *goal* that is congruent to the individual goals of the participants should be anchored with clear learning objectives. Against that background, a clear description of cognitive process dimension (remember, understand, apply, analyze, evaluate, create) should be considered in the process design (Krathwohl 2002). In the context of *product* layer, tangible and intangible artifacts are existent such as to enhance individual learning success by transfer, acquisition, and documentation of knowledge. The collaborative *activities* will help the participants to achieve those products. Moreover, the outcome of peer-learning reference processes represents a tangible artifact in the form of LM. The next layer, *procedures*, particularly focuses on the patterns of collaboration (generate, reduce, organize, clarify, evaluate, build consensus) and thinkLets[6] help to systematically structure the activities in order to achieve the collaborative products. To ensure LM quality, direct feedback focusing on the content of LM is needed. That demands for example thinkLets that help to evaluate the collaborative outcomes. Several requirements are expected from collaboration *scripts*. All necessary expertise like moderation know-how of a facilitator or pedagogical skills such as hints for correct teaching behavior, e.g. how to communicate feedback towards participants, should be contained in the design of a reference process for peer learning.

5.6 Contribution, Conclusion, Limitations, and Future Research

The PL-RPA is a conceptual design artifact that illustrates the conceptual foundations for how to design peer-learning reference processes. It proposes a model with research assumptions that illustrate the foundations for applying CE mechanisms in a new domain of 'learning' (see section 5.5.1). The PL-RPA itself can be described as a technique that illustrates the procedures for designing reference processes for PL (see section 5.5.2). The study contributes to the body of knowledge by providing prescriptive knowledge in the form of the mentioned *model*, inherent in the research assumptions for peer-learning reference processes (see Figure 17), and the mentioned *technique*, inherent in the PL-RPA (see Figure 19). According to (Gregor/Hevner 2013) both can be classified as principles of form and function of a theory of 'design and action'[7]. Practitioners such as lecturers receive insights on the things that need to be respected in order to systematically design PL activities.

Summarizing, in this chapter I developed the vision of reusable peer-learning reference processes with the help of CE methodologies enriched with requirements from the body of learning. I developed the concept of the PL-RPA. Peer-learning reference processes will have the potential to make organizations, universities, and companies independent from educators and to standardize inexplicit pedagogical methods and routines. University teachers, that are commonly experts in their domain and not experts with regard to pedagogical methods, will receive insights on how to stimulate a reusable HLL experience among their students. Thus, it allows reusability and the execution by facilitators and practitioners with moderation skills such as university teachers. The outputs of peer-learning reference processes can be used as knowledge base for the acquisition of factual knowledge and thus, bring about a second opportunity for knowledge transfer towards an extended group of people. The results provide first

[6] See section 2.2.3
[7] See section 3.2.2

insights of a structured and reusable way for overcoming challenges in knowledge transfer and documentation.

However, this study is not without limitations. The aim of the study was to derive insights on how to design reference processes for peer learning. Therefore I used mechanisms from CE and applied them to a new domain, the learning domain. Therefore, the conceptual development of PL-RPA is based on theory-driven foundations from PL and CE. Thus, the PL-RPA is not empirically validated in the field. Nevertheless, it shows how to cope with the set of unsolved problems inherent in systematically designing PL activities and opens entry points for a promising field of research.

Nevertheless, I focus in my thesis on the direct scope of peer-learning reference processes. Thus, the next step of my research are studies that addresses the process design and thus systematically designing PL activities and evaluating its effects. Against that background, the current study explains the conceptual foundations to apply mechanisms from CE in the field of PL. Against the widespread belief of the constructivist driven PL notion, the PL-RPA uses process restrictions from CE literature to enhance HLL activities. Against that background, HLL-RPA is an important basis to design peer-learning reference processes. It provides conceptual insights for the subsequent studies that are described in this this. To evaluate my idea and to gain insights into this promising field of research, the aim of the following studies is to focus on the design of reference processes for peer learning and its evaluation in the field. The studies will develop reference processes and aim to gain insights with regard to satisfaction measures with the PL experience; knowledge increases among participants in university classes (small and large) as well as the potential of transferring well designed PL reference processes to lecturers without training in tools and techniques. For that purpose, I will design and evaluate several peer-learning reference processes in chapter 6.

6 REFRENCE PROCESSES FOR PEER LEARNING (I–III): DESIGN, IMPLEMENTATION, EVALUATION

6.1 Peer-Learning Process Design for Knowledge Documentation to Leverage the Power of Collaborative Knowledge Transfer[8] (PL-PD)

6.1.1 Peer-Learning Process Design in the Context of the Thesis

In chapter 6.1 of my thesis I will address RQ 3a:

> What are characteristics and effects of peer-learning reference processes? *(Design, implementation, evaluation)*
>
> ➔ RQ 3a: What are characteristics of a peer-learning reference process for transfer and documentation of knowledge that can be used regardless of tool support and that helps learners to expand their knowledge base?

Answering RQ 3a serves as a means to indicate a first proof of value of systematically designed PL activities. More precisely, the results represent a proof of vale by applying mechanisms from CE and collaboration literature in the domain of PL. A *proof of value* aims to measure the efficacy of solutions and aims to demonstrate that a solution can be used to solve real problems. Typically the results are research products such as generalizable requirements, generalizable solutions, exemplar instances of solutions (Nunamaker Jr et al. 2015). For that reason it is highly important to gain insights into whether this is possible in the field and thus, to use and refine existing solutions from CE to develop solutions that enhance PL activities.

I focus on collaborative knowledge transfer and documentation, since knowledge documentations that are enriched with visualizations represent a sophisticated understanding of knowledge concepts and their relationships. Hence, this kind of documentation has the potential to refer to the upper levels of Bloom’s revised taxonomy. In order to respect transferability aspects of peer-learning reference

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[8] The insights presented in this chapter are based on a publication on this topic: (Oeste-Reiß/Söllner/Leimeister 2016). Thanks to my collaborators, the reviewers, and attendees of the HICSS 2016 for their valuable feedback and the captivating discussions on my work. Thanks to all participants for participating in the evaluation of PL-PD during the walkthroughs and pilot schemes.

processes, IT tool support should be taken into consideration. However, a first step is to analyze whether PL activities can be designed by using CE mechanisms, which are characterized by certain process restrictions in terms of learner behavior. For that reason, chapter 6.1 describes the process design of such a reference process, the Peer-Learning Process Design (PL-PD), and its evaluation with paper-based and IT-supported tools.

To answer RQ 3a and to gain insights into the demands described above, I conduct a study in which I develop and evaluate the design artifact of the *PL-PD*. This artifact aims at enhancing knowledge transfer and documentation and follows a DSR approach (Peffers et al. 2006b; Gregor/Hevner 2013). The PL-PD is a reference process that describes the design of PL activities, including instructions, tool support, and work products (collaborative outcome of several activities). The evaluation outlines qualitative and quantitative measures in order to iteratively refine the process design. The evaluation also aims at gaining insights into whether the PL-PD has the potential to increase the knowledge base among learners if they document knowledge. Another important question is whether learners are satisfied with the process and are able to follow all activities. The PL-PD was tested with paper-based as well as IT-supported tool support. The results show that the PL-PD has the potential to increase the knowledge base among learners. Furthermore, the learners are satisfied with the results. This indicates that they are able to follow the collaborative work practice with its PL activities.

6.1.2 Study Outline and Research Approach

As already described above, transfer of existing knowledge among people becomes increasingly important for organizations in order to remain competitive on the market. Even though the digital age allows for new ways of team collaboration, there are still unsolved problems in terms of knowledge transfer. Thus, it is important to analyze PL activities that have the potential to enhance knowledge activities. Hence, the section focuses on the development of the PL-PD that stimulates knowledge transfer resulting in a high-quality knowledge document. I ground my research on insights from PL and CE literature to develop and to evaluate the PL-PD. The PL-PD uses process restrictions from CE to systematically enable PL effects among the participants. Practitioners can use the reference process of PL-PD to initiate PL activities for knowledge transfer and documentation. The aim of the study is therefore to develop a PL-PD which promotes knowledge transfer and documentation with respect on how to apply the PL-PD with different tool support (offline vs. online). I illustrate that my PL-PD is applicable with and without IT-supported tools.

De Vreede et al. (2009a) point out in their research agenda that the application of CE mechanisms to new domains such as the learning domain constitutes a research gap. With this design science study, I contribute to CE research in a new application domain. I provide a new solution to leverage the benefits of knowledge transfer and thus to enable learning effects. Since the study presents a design science initiative, I aim to make a contribution that can be classified in line with Gregor and Hevner (2013) as a contribution of the type “improvement”. The documentation of the PL-PD and its instructions serve as generalizable solution and can further be classified as a “principle of form and function” in the context of a nascent design theory. In order to achieve this goal, I structure my study by using Hevner’s design science research framework (Hevner 2007; Gregor/Hevner 2013), see Figure 20.

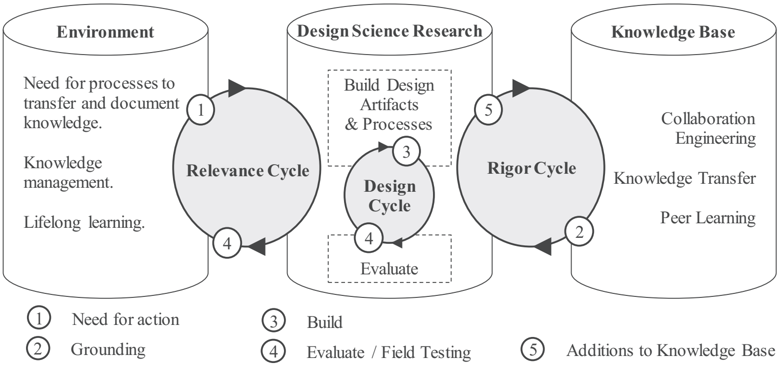


Figure 20: Design Science Cycles
Source: (Oeste-Reiß et al. 2016) adapted from Hevner (2007)

First, I identify the lack of solutions for systematic knowledge transfer and documentation in the upper half of the relevance cycle (see section 6.1.3). Based on the problem statement, I deduct the design goals for the artifact of the PL-PD to solve this problem. Second, I study CE, PL, and knowledge management literature in order to develop a first version of the PL-PD. I complete a rigor cycle by grounding the design of PL-PD on scholarly literature from the fields of CE (see section 6.1.4.1) and PL (see section 6.1.4.2) as well as derive a working definition of knowledge transfer (see section 6.1.4.3). This way, I inform my design choices in order to derive generalizable requirements and principles of form and function inherent in the PL-PD. Thirdly, driven by the needs from the practical problem situation, I complete the design cycle (see section 6.1.4.3). I design the PL-PD, build exemplary instances with paper-based and IT-supported tools, and iteratively evaluate it to derive a generalizable solution of the

PL-PD. For that reason, I take the PL-PD back into the field to test it in the pilot scheme with real-problem stakeholders (see section 6.1.6) such as experts in CE, lecturers, and students that participate in the learning experience of PL-PD. I decided to use students for the pilot scheme since I needed to ensure that the PL-PD worked before I could apply a broad rollout in companies. Since I can expect that there will be more and less knowledgeable students, students are a good substitute for the pilot scheme (Sangin et al. 2008). To evaluate the PL-PD I use an exploratory research design comprising of simulations, walkthroughs and pilot schemes, which allows for unexpected findings and flexible design adaptions (Mayring 2004). In order to allow for a holistic view, I chose a mixed methods approach to validate the design of the PL-PD. While I completed the relevance cycle, this validation showed that the designed artifact would be suitable to solve the defined problem outlined in RQ 3a. I analyzed the use of the PL-PD in this instantiation in order to evaluate its effectiveness. I used insights from the design validation to iterate them in the design phase in order to give recommendations for design improvements and practical notes about the use of the PL-PD as well as about tool support.

6.1.3 Problem Statement and Design Goals

With the advent of the digital age and the ubiquity of information, knowledge workers need to be aware of factual knowledge. They have to be able to apply, analyze, evaluate, and create that knowledge as well as to improve soft skills such as teamwork, communication, and cooperation (Schulz 2008). Besides the application domain of PL in large university classes, the scope of systematically designed PL activities is also highly relevant for companies. In order to remain competitive in the market, the productive transfer and retention of knowledge among people becomes increasingly important for companies (David/Foray 2003). Consequently, in order to effectively stimulate transfer and retention of knowledge among people, reusable PL activities are a promising solution. Until now, such knowledge activities often fail, since knowledge transfer often takes place unconsciously or due to the shortcomings of existing approaches. Such knowledge activities often lack an additional benefit for the involved people such as increases in the own knowledge base, or incorrect and incomplete knowledge documentations. In addition, the individuals (e.g. employees) often are not proactively involved in such knowledge activities and perceive the provided technologies as to be complex and difficult. Moreover, open-ended PL tasks such as creating complex knowledge documentation seem to overstrain the individuals, and thus lead to resistance behavior. Consequently, the individuals decline such knowledge activities. In this context, the central problem constitutes the way knowledge transfer become managed and more precisely on how the knowledge activities are structured.

Since knowledge activities underlie PL activities, existing research in the context of PL addresses methods such as peer questioning and peer discussions in order to enhance structured interactions (King 2002) and foster knowledge transfer among learners. This, however, focuses only on discussions and lacks a common outcome in the form of knowledge documentation. Moreover, it is questionable whether those PL activities have the potential to sustainably enhance learning effects with increases in the knowledge base among all involved learners. Furthermore, such PL interactions can often only be structured up to a certain degree. In order to provide facilitation guidance for learners' interaction among each other, so-called collaborative learning scripts are existent. Those scripts address interaction sequences among learners and give precise instructions on how to interact with each other (King 2002; Kollar/Fischer/Hesse 2006; Kopp/Mandl 2011). However, the focus is typically on enhancing learning success on lower learning levels and not on generating common output, such as knowledge documentation that typically represents to the upper levels of Bloom's revised taxonomy. Documenting knowledge in a way that it can be used as basis for knowledge acquisition for third parties requires a deep and sophisticated understanding of the knowledge domain. To achieve a deep and sophisticated understanding of the knowledge domain requires inter alia an understanding of the several knowledge concepts and how they relate on each other (see section 2.1.4). Nevertheless, collaborative learning scripts provide guidance on how to manage the process of collaborative learning activities.

In this context, CE helps to split structure in PL activities and to facilitate the collaboration towards a common outcome such as a knowledge document. The resulting interaction among individuals stimulates knowledge production, produces cognitive gains, and improves people's soft skills (King 2002). However, the focus of CE is more on managing collaborative activities than on enhancing individual learning. Thus, in this study I apply CE to a new domain. I use the insights from the PL-RPA (see chapter 5) to derive a generalizable solution for a reference process, the PL-PD. After all, the collaboration on common material such as a knowledge document has the potential to transfer knowledge among participants, to deepen the understanding, and to retain knowledge. In the context of large university classes, the latter is more or less instrumental to enhance knowledge transfer and learning effects. In the context of companies, which need to retain their knowledge to cope with demographic change and job rotation, it is a highly valuable output (Leimeister 2015).

The design goals of this study therefore are:

- *Design Goal 1: Leverage the power of collaborative knowledge transfer to enhance knowledge increases among the learners.*
- *Design Goal 2: Package sufficient collaboration expertise in the design of the PL-PD so that it can be executed with and without IT tool support.*

6.1.4 Related Work

6.1.4.1 Collaboration Engineering

A detailed design methodology is necessary to focus collaborative activities on knowledge transfer and documentation. The design methodology should provide procedural guidance on how to systematically split structure and to describe collaborative activities for the transfer and documentation of knowledge. It should lead to a PL-PD that is easily understandable and applicable with different tool support. In addition, it should facilitate PL activities to reliably improve reflection and application of knowledge as well as soft skills. CE is an approach for designing collaborative work practices for high-value recurring tasks, and deploying them without the ongoing support from a professional facilitator or collaboration engineer (Briggs et al. 2006). In that case, collaboration can be described as the work of two or more people on common material, which is characterized by coordination, communication, and cooperation (Leimeister 2014). In section 2.2 of this thesis I described the central foundations of CE. To transfer the theoretical understanding of CE to my study, Table 34 depicts the applicability of CE for the problem situation of the current study. The left column represents the criteria for using CE as a design methodology (Leimeister 2014); the right column describes the context of the PL-PD in my study and explains the suitability of CE:

Collaboration Engineering	Context of the Design Artifact (PL-PD)
Collaborative work practice	Activities for transferring and documenting knowledge constitute a recurring collaborative work practice.
High value task	Transfer and documentation constitutes a high value tasks since it helps qualify knowledge workers – e.g. participants of PL-PD achieve expertise increases (expand their individual knowledge base and soft skills) while transferring knowledge; companies can remain competitive on the market, since PL-PD helps them to retain valuable knowledge of knowledge workers.
Recurring task	Transfer and documentation constitute recurring tasks in the context of lifelong learning – e.g. lecturers in universities have to stimulate PL activities for HLL in order to provide high-quality education; companies face challenges of employee turnover and demographic change.
Collaboration engineer	Designer of the PL-PD (author of the thesis).
Facilitator	Person with moderation skills.
Practitioner	Participants in the form of learners (e.g. students, employees).

Table 34: Collaboration Engineering in the Context of the PL-PD
Source: based on Oeste-Reiß et al. (2016)

In order to design the PL-PD in a reusable way so that it systematically stimulates PL activities for knowledge transfer and documentation, I use the Collaboration Process Design Approach (CoPDA) (Kolfschoten/de Vreede 2009a). The use of the CoPDA helps us to split knowledge transfer tasks into concrete activities and derive a reusable design of PL-PD. The CoPDA consists of five steps:

- *Task diagnosis* as first step includes an analysis of task, stakeholders, and resources. It ends with the definition of goals and products (outcomes) of a collaborative work practice (Kolfschoten/de Vreede 2009a).

- *Task decomposition* is the second step. Depending on the goals and products, and subproducts, appropriate collaborative activities are defined. A group (participants of a collaborative work practice) has to take part in these activities in order to develop the several products and to achieve the common goal. Group procedures such as the patterns of collaboration (PoC) [generate, reduce, clarify, organize, evaluate, and build consensus] help to split structure in collaborative activities (Kolfschoten/de Vreede 2009a).

- *thinkLet choice* is the third step. A thinkLet is a named, scripted, reusable, and transferable sequence of collaborative activities (Briggs et al. 2006) that serves as a building block for collaborative process designs (Kolfschoten/de Vreede 2009a).

- *Agenda building* is the fourth step. It consists of developing an internal agenda / moderation plan that describes specific questions and instructions for every activity. Moreover, it comprises a facilitation process model (FPM) that gives an overview of the collaborative work practice (Kolfschoten/de Vreede 2009a).

- *Design validation* is the fifth step and refers to an evaluation of the collaborative work practice in the field (Kolfschoten/de Vreede 2009a).

6.1.4.2 Peer Learning

From a pedagogical point of view, constructivist learning theory provides useful basics. Constructivist learning theory focuses on people who are learning from experiences. Individuals are actively involved in the learning activities and experience the environment. They achieve learning effects and thus, increases in their knowledge base by social interactions with other learners (Moll 2013). During the collaboration with others they reflect, apply, evaluate, and create knowledge, and they improve their soft skills.

The work of Moore (1989) differentiates between three interaction types: learner-learner interaction, learner-lecturer interaction, and learner-content interaction. I consider these interaction types, because interaction provokes learning activities that demand an exchange between learners, lecturers, and content (Moore 1989). Learners who interact with lecturers are more actively involved and receive a higher degree of knowledge gain compared to those who do not interact. The question-answer game is the classic form of *learner-lecturer interaction*. Learners have the opportunity to contribute their ideas and thoughts as well as request clarification of unclear issues. The *learner-learner interaction* enables a direct exchange and fosters the individual reflection ability. Feedback on one's own performance leads to an awareness and an understanding of how to control their learning. Conversations and discussions increase learner motivation (Eisenkopf 2010) and learning success (Moore/Kearsley 2011). *Learner-content interaction* takes place by examining learning content, e.g., in the form of text, audio, or video (Moore/Kearsley 2011). The interaction types give important insights why interaction is necessary for learners' performance. In that context, PL and related forms aim to elicit different PL activities and address the three interaction types.

PL is an instruction method in which learners work in groups and learn from each other (King 2002). Learners help each other, provide guidance, and monitor their understanding. They work independently at different stages, interact with each other, and conduct joint work in larger groups (Oeste et al. 2014). Reciprocity in the social interactions is necessary to ensure feedback between learners (Harris 1998). This fosters the development of critical thinking, clarification of contributions, assessing others' contributions, as well as improving soft skills such as teamwork, communication, cooperation, or critical thinking. In addition, the learners become responsible for their activities (Topping 2005) while a lecturer guides them and communicates explicit expectations (Harris 1998). Focusing on the outcome of collaborative learning activities leads to *peer creation*. An outcome can be knowledge gain or knowledge documentation. From that point of view, peer creation always takes place in the context of PL. Peer creation literature provides useful mechanisms for the co-creation of knowledge. Learners add their knowledge to the learning content. In doing so, a clear assignment and focused instructions are necessary. The lecturer has to make learners accountable for their work (Hall/Stegila 2003). With regard to the assignment structure, *cooperative learning* provides additional insights. In small groups of up to six people, learners solve assignments. These assignments are divided into subtasks, from which successive tasks follow. The learners are dependent on each other and are accountable for their actions (Hall/Stegila 2003). In order to provide direct feedback to the learners as well as to ensure correction mechanisms, *peer review* gives additional insights. Learners assess one another's work and give each other feedback (Parece/Mulder/Baik 2009). In order to ensure constructive feedback, the lecturer provides explicit feedback criteria. This way, a peer review enables a wide range of feedback perspectives (Parece/Mulder/Baik 2009).

6.1.4.3 Working Definition of Knowledge Transfer

To generate a common understanding of knowledge transfer and knowledge documentation I derive in this section a working definition. In order to define knowledge, Krathwohl (2002) differentiates between factual knowledge, conceptual knowledge, procedural knowledge, and metacognitive knowledge: *Factual knowledge* comprises basic elements to solve a problem (Krathwohl 2002). *Conceptual knowledge* refers to the interrelationships among knowledge concepts (Krathwohl 2002). *Procedural knowledge* refers to knowledge on how to do something, and how to use e.g. methods (Krathwohl 2002). *Metacognitive knowledge* refers to the cognition in general (Krathwohl 2002).

To take into account, the ubiquity of information allows an easy access to factual and conceptual knowledge. In contrast, procedural and metacognitive knowledge often are tacit. Such knowledge is more valuable, since it is often only visible in an indirect manner, such as actions by a person or within a certain context (Nonaka 1994). Typically this knowledge demands a more sophisticated understanding of the knowledge concepts and its relationships. In consideration with the expertise definition (see section 2.1.4) and the aim of enabling HLL effects, the scope of reference processes for PL is beyond the factual knowledge. To achieve such knowledge increases and thus, learning effects, knowledge transfer is required. To enable a knowledge transfer, commonly social interactions between at least two people take place (Oeste/Söllner/Leimeister 2014).

Figure 21 depicts the working definition of knowledge transfer. The transfer of procedural and metacognitive knowledge will benefit from social interactions. Therefore, collaboration between at least two people is necessary (Nonaka 1994). This collaboration has the potential to enable exchange, reflection, application, evaluation, and creation of knowledge (Moll 2013). Consequently, knowledge transfer will have twofold benefits.

- First, a direct knowledge transfer among the involved people can occur in the form of knowledge gains. The involved people acquire knowledge as well as improve their soft skills such as teamwork, communication, cooperation, or critical thinking while they document knowledge.

- Second, an indirect knowledge transfer to third parties can occur through the knowledge documents that are created by the collaborative activities. The knowledge becomes retained and serves as a resource of indirect knowledge transfer for third parties.

This study focuses on the design of collaborative activities that enable knowledge transfer in order to foster knowledge gains for the involved people as well as to empower the involved people to document their knowledge in an appropriate way.

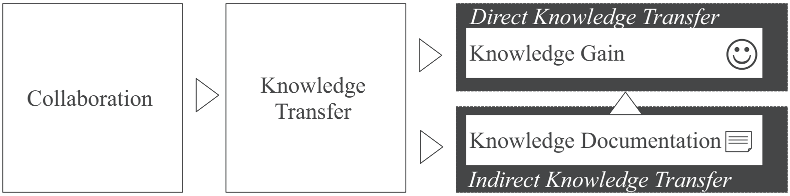


Figure 21: **Working Definition of Knowledge Transfer**
Source: based on Oeste-Reiß et al. (2016)

6.1.5 The Peer-Learning Process Design

In this section, I describe the design of the PL-PD with its sequence of collaborative activities as generalizable solution. The PL-PD aims to enable PL activities in a systematic and reusable way in order to provoke knowledge transfer. In section 6.1.5.1 I derive generalizable requirements from the body of PL and in section 6.1.5.2 I describe the design of the PL-PD and use a FPM and an internal agenda for illustration issues.

The output of PL-PD activities is a knowledge document that should serve as resource for an indirect knowledge transfer for third parties and should be instrumental to support the direct knowledge transfer among the participants of the PL-PD. The collaboration among each other helps the participants to receive an individual knowledge gain and codify their procedural and metacognitive knowledge. Therefore, a knowledge document will be the collaborative outcome of the PL-PD. As described in chapter 5 (more precisely, see Figure 19), the kind of outcome also sets requirements to the design of a collaborative work practice such as the PL-PD. Thus, below I briefly discuss which kind of knowledge document is appropriate to codify procedural and metacognitive knowledge. As described in section 6.1.4.3, procedural and metacognitive knowledge have an explanatory character and focus on explanations on how to do something. Therefore, the nature of the knowledge document should address this characteristic. In such context, explanation videos, respectively, the storyboards for explanation videos are knowledge documents that have the potential to convey this claim. They explain a solution for a complex problem in an easily understandable language and are enriched with visual animations (Chen/Wu 2015). The visualization of complex knowledge concepts in an abstract manner demands a sophisticated understanding of knowledge and thus, has the potential to enable HLL effects. The development of an explanation video requires a storyboard. The storyboard contains all relevant knowledge and requires a precise examination and reflection of the knowledge. It documents the explanation of knowledge in the form of text and visualizations. For that reason, the collaborative outcome of the PL-PD is a knowledge document in the form of a storyboard.

6.1.5.1 Generalizable Requirements for the Peer-Learning Process Design

In this section I illustrate generalizable requirements to design a PL-PD for knowledge transfer and documentation. I derive the generalizable requirements from scholarly literature on PL (see section 6.1.4.2) to inform my design choices for creating the PL-PD. Table 35 illustrates the generalizable requirements according to the three types of interaction.

Interaction Type	**Generalizable Requirements from Peer Learning (GR)**	
Learner-Learner Interaction (Gagné 1984; Harris 1998; Dillenbourg 1999; Krathwohl 2002; Hall/Stegila 2003; Topping 2005; Parece/Mulder/Baik 2009)	GR 1	*Group formation:* Put together a group of learners and reconcile them on the same knowledge.
	GR 2	*Reciprocity:* Foster social interactions between learners by providing assignments that demand discussions and the creation of a collaborative outcome as well as tools that support the collaboration in a reciprocal manner.
	GR 3	*Interdependence:* Ensure positive interdependence between learners through tools and assignments.
	GR 4	*Accountability:* Use social pressure to make learners accountable for their activities.
	GR 5	*Group atmosphere:* Constitute a positive group atmosphere by empowering learners to add value to their activities.
	GR 6	*Objectives:* Ensure focused learner activities by providing learning objectives.
Learner-Lecturer Interaction (Harris 1998; Parece/Mulder/Baik 2009; Jones 2014)	GR 7	*Lecturer:* Provide a lecturer to guide the learners though their PL activities.
	GR 8	*Expectations:* Communicate explicit expectations (e.g., instructions on how to solve learning assignment; quality indicators for the collaborative outcome) to learners to ensure focused PL activities.
	GR 9	*Feedback:* Give learners direct feedback about their learning progress.
	GR 10	*Constructive Feedback:* Ensure constructive feedback by providing feedback criteria.
	GR 11	*Reflection:* Ensure discussions between learners by means of discussing the solution of an assignment or solution aspects with other learners.

Learner-Content Interaction (Hall/Stegila 2003; Leacock/Nesbit 2007; Jones 2014)	GR 12	*Type of assignment:* Provide an assignment that demands learners to brainstorm solution aspects on their own before discussing it in the group with other learners.
	GR 13	*Assignment structure:* Divide assignments into subtasks which build on each other.
	GR 14	*Assignment wording:* Define the assignments clear and in an understandable manner (e.g., question, nature of outcome, time).
	GR 15	*Structure of outcome:* Pay attention to a logical and consistent way of documentations by providing templates.
	GR 16	*Complexity of outcome:* Pay attention to an easily understandable language of collaborative outcomes. Demand abstract visualizations and descriptions of complex knowledge concepts.
	GR 17	*Correctness of outcome:* Ensure correctness of collaborative outcomes by means of proofreading and peer-review mechanisms.

Table 35: **Generalizable Requirements for Enhancing Knowledge Transfer**
Source: based on Oeste-Reiß et al. (2016)

6.1.5.2 The Peer-Learning Process Design as Generalizable Solution

I used the CoPDA (see section 6.1.4.1) to derive a reusable and structured collaborative work practice in the form of the PL-PD (Vreede/Briggs/Massey 2009a). The design choices respected the generalizable requirements from the section before.

Collaboration Goal

Following the CoPDA, the development of a collaborative work practice starts with the definition of the common goal. A common goal is one that refers to the state, extent, time, and scope of a goal (Leimeister 2014). In the context of the PL-PD, this can be described as follows: *"To increase the individual knowledge base, participants collaboratively develop one storyboard for an explanation video that describes complex knowledge in the form of abstract visualizations and brief text explanations within the next six hours. The storyboard contains procedural knowledge on how to do something."* The description of the PL-PD comprises a FPM (see Figure 22) and an internal agenda (see Table 36).

Preparation

The person who will conduct the PL-PD and thus facilitate the PL activities has to make the following preparations to build an exemplary instance of PL-PD:

- *Plenary group size*: The PL-PD can be used for plenary groups with a size of min. 10 and max. 30 participants.
- *Subgroup size*: The PL-PD can be used for subgroups with a size of min. 2 and max. 6 participants.
- *Number of subgroups*: The number of subgroups depends on the number of subtasks (= knowledge topics/categories) that the facilitator prepares – e.g. five subtasks = 5 subgroups.
- *Assignment and subtasks:* The facilitator has to create an assignment (learning task) that can be divided into independent subtasks. Those subtasks refer to knowledge topics and categories. Activities 1 and 3 demand for independent subtasks.
- *Duration*: Based on the maximum number of subgroups of five the PL-PD will have duration of six hours.
- *Scenes*: The number of scenes will occur during the PL-PD. Thus, the facilitator has to divide the number of identified scenes equally to the number of subgroups.

Facilitation Process Model (FPM)

The *FPM* (see Figure 22) gives an overview of the PL-PD. It illustrates all collaborative products and the sequence of activities that guide the collaboration.

Activities 1 and 2 focus on reflecting knowledge in general. The intention is to clarify relevant knowledge, create a shared understanding, and trigger cognitive processes among less knowledgeable participants. The fact, that all participants can read the contributions from all other participants helps to achieve the described intention. *The focus of activities 3 to 5 is to create a rough concept of the storyboard*, clarify the focus of the storyboard, and organize first ideas. In order to structure the ideas, a s*toryline with key scenes is developed during activity 6.* The participants join in a plenary discussion and derive key scenes for the storyboard. With this in mind, the *refined concept of the storyboard* is developed during the *activities 7 to 9*. By means of several evaluations, the *correctness of the documented knowledge* is ensured. *Activity 10* gives insights into whether the collaboration ends or refinement is needed.

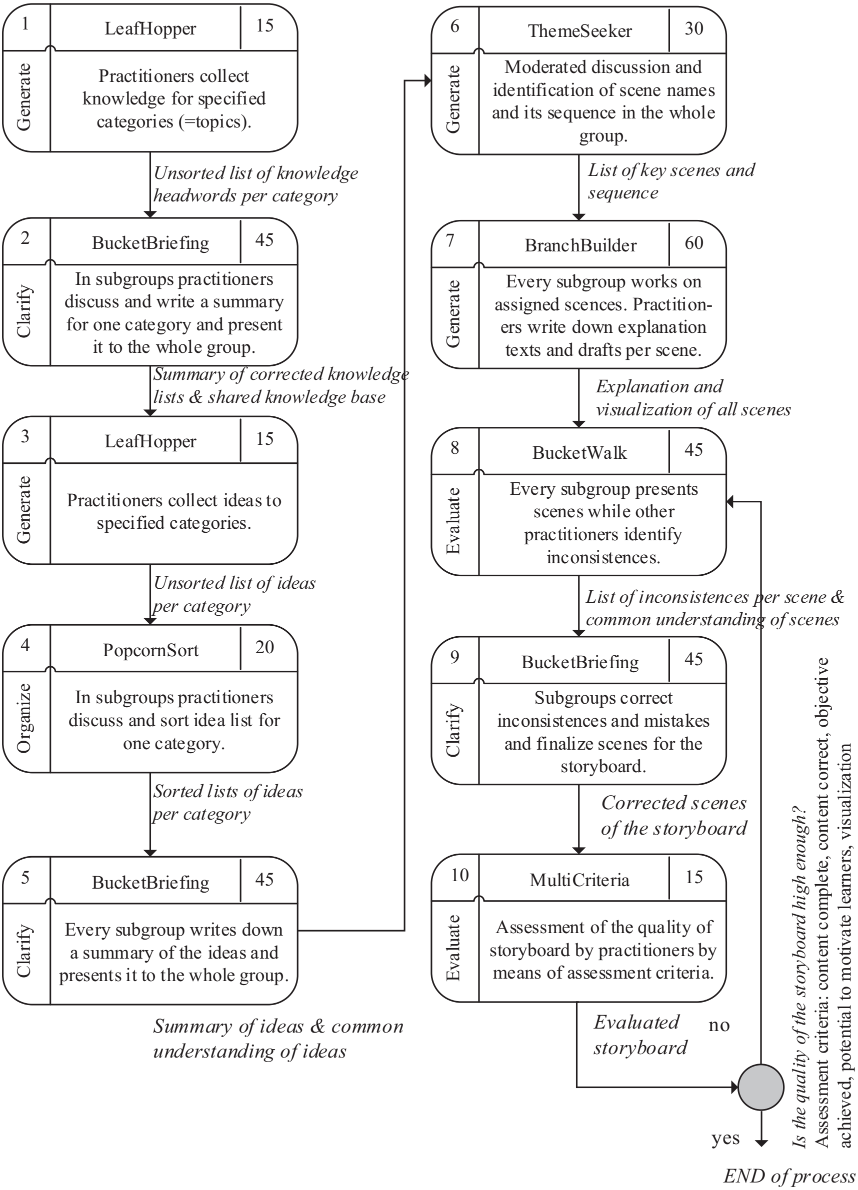
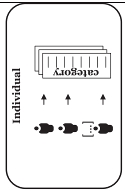
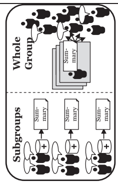


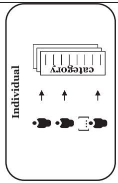
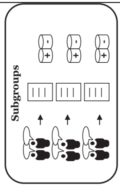
Figure 22: **FPM of the Peer-Learning Process Design**
Source: based on Oeste-Reiß et al. (2016)

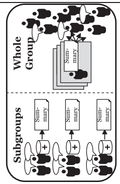
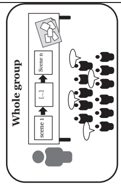
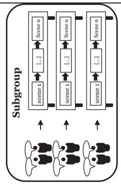
Internal Agenda (Moderation Plan)

The *internal agenda* (see Table 36) is more detailed and gives concrete hints on how to conduct the PL-PD. The internal agenda has the character of an abstract generalizable solution that can be used by facilitators to build an exemplary instance of PL-PD. It refers to the formation of groups, the PoC and thinkLets, group products and activities, as well as the corresponding assignments and instructions. In order to illustrate that the same PL-PD is applicable with different tool support, I provide a column for using paper-based tools as well as a column for using IT-based tools. In this way, I expand the internal agenda by addressing the two columns of tool support. In addition, the internal agenda depicts how the requirements from scholarly literature on PL are incorporated into the PL-PD.

The internal agenda itself addresses some requirements in general. For instance, GR 6 is addressed by defining a clear objective for the PL-PD. GR 7 and GR 8 are respected, since the PL-PD will be conducted by a facilitator who receives instructions for communicating expectations to the practitioners from the internal agenda. Overall, the internal agenda describes the assignments for the collaborative activities and illustrates the timeline. Accordingly, GR 13 to GR 15 are generally addressed.

min	Group formation	PoC / thinkLets	Collab. product	Activities	Assignment and instructions	Paper-based tools	IT-based tools	GR
00: 20		Warm up	Common under-standing of objective	Facilitator and practitioners introduce themselves. Facilitator presents agenda and the objective of the workshop.		Presentation	Presentation	GR 5, GR 6
00: 15		GENERATE LeafHopper	Unsorted list of knowledge headwords per category	Facilitator explains categories of knowledge and expectations for solving the assignment. Individually practitioners write down knowledge in the form of headwords, and read and comment contributions from others.	Please, individually collect and write down your knowledge in the form of headwords. Use the following categories: - knowledge topic 1 - knowledge topic […] - knowledge topic 5). You are allowed to switch between the categories. According to your expertise, you are allowed to read or add comments to contributions or write down new contributions to the categories.	Boards, colorful cards (one for each category), markers	GSS: Login for every practitioner Brainstormin g pages (one page per category)	GR 4, GR 5, GR 11, GR 12
00: 45:		CLARIFY BucketBriefing	Summary of corrected list of knowledge headwords Shared knowledge base	Facilitator divides practitioners into subgroups and assigns every subgroup to one category with a list of knowledge headwords (number of subgroups = number of categories) from the brainstorming activity before. Facilitator explains assignment. Practitioners discuss the knowledge contributions per category, correct mistakes, and write down a summary in subgroups.	Please, discuss in your subgroup the knowledge contributions of the category. If you find a mistake, please correct the mistake. Then, write down a short summary about the knowledge according to the list of knowledge headwords per category. [20min] Select one person from your subgroup to present the summary. Every subgroup has 5 minutes for presenting the solution. [25min]	Template for correcting the mistakes	GSS: Brainstormin g pages with solutions and comments Function for correcting and summarizing	GR 1, GR 2, GR 3, GR 4, GR 5, GR 9, GR 11, GR 16, GR 17

00: 15		GENERATE LeafHopper	Unsorted list of ideas per category	Facilitator explains categories to brainstorm ideas and expectations for solving the assignment. Individually, practitioners write down knowledge in the form of headwords, and read and comment contributions from others.	Please, individually collect and write down your ideas for the storyboard among the categories - core message, - dramaturgy, - knowledge topics, - example of use, - character/avatar in the form of headwords. You are allowed to switch between categories. According to your expertise, you are allowed to read or add comments to contributions or write down new content to the categories.	Boards, colorful cards (one for each category), markers	GSS: Login for every practitioner Brainstorming pages (one page per category)	GR 4, GR 5, GR 11, GR 12
00: 20		ORGANIZE PopcornSort	Sorted lists of ideas per category	Facilitator divides practitioners into subgroups and assigns every subgroup a category with a list of ideas (number of subgroups = number of categories). Facilitator explains assignment. Practitioners discuss and sort lists of ideas on the basis of relevant or irrelevant contributions.	Please, discuss the ideas of the assigned category in your subgroup. Summarize redundant ideas to one idea. Then, sort the ideas by assigning them into the following containers: - Relevant ideas - Irrelevant ideas	Per subgroup two flip charts for each category	GSS: Transfer data to new brainstorming page Drag & drop function for organizing	GR 1, GR 2, GR 3, GR 4, GR 5, GR 9, GR 10, GR 11, GR 17

00: 45		CLARIFY BucketBriefing	Summary of ideas and common understanding of ideas	Practitioners stay in subgroups. Facilitator explains assignment. Practitioners discuss the ‘relevant ideas’ per category, correct mistakes and write down a summary within their subgroups.	Please, discuss in your subgroup the ‘relevant ideas’ of the category. If you find a mistake, please correct the mistake. Then write down a short summary of the ideas. [20min] Select one person from your subgroup to present the summary of the idea lists. Every subgroup has 5 minutes for presenting the solution. [25min]	Template for correcting the mistakes	GSS: Brainstorming pages with solutions and comments Function for correcting and contributing	GR 1, GR 2, GR 3, GR 4, GR 5, GR 9, GR 11, GR 16, GR 17
00: 30		GENERATE ThemeSeeker	List with key scenes and its sequence	Facilitator moderates a discussion for the topic “What are key scenes?”. Practitioners discuss and identify key scenes while the facilitator notes it with a scene name and a short draft. Discussion ends until no additional scenes are identified.	Let us discuss in the whole group the following topic: “What are key scenes for the storyboard?” Please tell me the name of a key scene and I will note its name and make a short draft.	Board, marker, DIN A4 templates for noting scenes	GSS: Brainstorming pages (one page per scene)	GR 1, GR 5, GR 11,
00: 60		GENERATE BranchBuilder	Explanation and visualization of all scenes	Facilitator divides practitioners into subgroups and assigns every subgroup a sequence of scenes (number of subgroups = number of sequences of scenes) and explains the assignment. Every subgroup works on a different sequence of scenes. Practitioners edit the assigned scenes: they make a draft and write down an explanation text per scene.	Now we have a good first draft of the storyboard. Please, elaborate in your subgroups the assigned sequence of scenes. Use the template for tracing the drafts and writing down the explanation texts.	Markers, template for draft and explanation text	GSS: Per Scene one brainstorming page Paper template for draft	GR 1, GR 2, GR 3, GR 4, GR 5, GR 11, GR 16

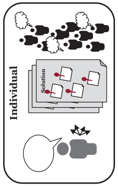
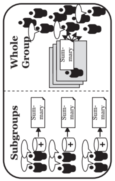
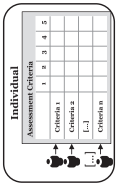
00: 45		EVAL-UATE BucketWalk	List with inconsistenci es per scene and common understandin g of all scenes	Successively, the facilitator presents the solutions from the subgroups to the practitioners. He asks practitioners for each scene description, whether there are mistakes in the solution and what a better formulation of the solution can be. Practitioners write down comments per solution of the subgroups on their own.	Please, listen to the presentation of the solutions for the several scenes. If you find mistakes or inconsistencies, mark them and write down your comments for improving it. - Is there a mistake in the solution (= scene description)? - What is a more precise formulation of the solution (= scene description)?	Boards with solutions, Post-its for comments, markers	GSS: Brainstormin g pages with solutions Function for commenting and contributing	GR 1, GR 2, GR 3, GR 4, GR 5, GR 9, GR 10, GR 11, GR 17
00: 45		CLARIFY BucketBriefing	Corrected scenes of the storyboard	Practitioners go back to their subgroups. Facilitator explains assignment and assigns every subgroup a list with inconsistencies per scene. Practitioners discuss the identified inconsistencies per scene and correct mistakes in subgroups.	Please, discuss in your subgroup the inconsistencies per scene and then correct the mistakes in the scene. [20min] Select one person from your subgroup to present the corrected scenes. Every subgroup has 5 minutes for presenting the solution. [25min]	Template for correcting the mistakes	GSS: Brain-storming pages with solutions and comments Function for commenting and contributing	GR 1, GR 2, GR 3, GR 4, GR 5, GR 9, GR 11, GR 16, GR 17
00: 15		EVAL-UATE MultiCriteria	Evaluated storyboard	Facilitator explains assignment, assessment criteria, and assessment mechanism. Practitioners vote. Collaboration ends if there are no mistakes in the solution and all are satisfied.	Please, evaluate whether you are satisfied with the type and correctness of the knowledge documentation in the form of the storyboard. For every assessment criterion, you have one vote on a scale from 1 [bad] to 5 [very good].	Flip chart with assessment criteria, glue dots	GSS: New Multi Criteria Voting	GR 4, GR 9, GR 10, GR 17

Table 36: **Internal Agenda of the Peer-Learning Process Design**
Source: based on Oeste-Reiß et al. (2016)

6.1.6 Validating the Peer-Learning Process Design

6.1.6.1 Methodology

In order to ensure a high quality of the PL-PD and to receive recommendations for applying the PL-PD with different tool support, I use an extensive design validation to evaluate and refine the PL-PD. Thus, the validation builds on a mixed methods approach and aims to gain insights with regard to my outlined research question and the two design goals of this study.

In total, the validation comprises four iterations and completed four design and evaluate cycles (see Figure 23). I started in 2014 and iteratively validated the PL-PD during four design/evaluate cycles. After every cycle, I took the PL-PD back into the field and tested it with real stakeholders, refined it, and developed a new version of the PL-PD for the next iteration (see Figure 23). Thereby, I iteratively passed through the CoPDA. I used a mixed methods approach that comprised qualitative and quantitative data (Leimeister 2014). Figure 23 depicts the four cycles and connects them with the evaluation types I used and the amount of data I gathered by the three different groups of stakeholders.

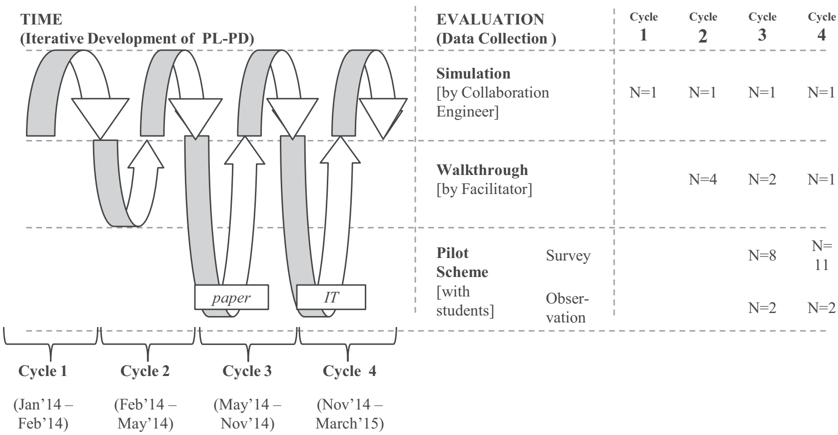


Figure 23: Validating the PL-PD: Iterative Development and Data Basis
Source: based on Oeste-Reiß et al. (2016)

To provide a detailed description about the context, the paricipants, the data collection methods and its measures, as well as the procedures the following characteristics are existent.

Context of the Study and Selection of Participants

The validation of the PL-PD started in January 2014 and iteratively completed four design/evaluate cycles. To gather insights for achieving the design goals of this study (DG 1 – leverage the power of collaborative knowledge transfer; DG 2 – package collaboration expertise), different stakeholders participated in the validation during that time:

- *Collaboration Engineer:* In the role as the collaboration engineer of the reference process I conducted a simulation for each version of the PL-PD.

- *Facilitator*: Independent experts examined the reference process of the PL-PD during a walkthrough on whether there are stumbling blocks in the process design. Those experts had an information systems and collaboration engineering background and thus, had moderation expertise. Moreover, all facilitators had competences in teaching university classes. Among all cycles a total of N=7 facilitators participated in a walkthrough to examine PL-PD.

- *Students*: A master's course that was taught at a German and a Swiss University was the basis for the evaluation of the PL-PD in the field with real stakeholders. The topic of the master's course was "Collaboration Procedures". The pilot scheme was only conducted in the cycles 3 and 4 as a voluntary learning experience. A total of N=19 students participated in the PL-PD.

Mixed Methods Approach – Procedures and Measures

The data acquisition is characterized by using different *evaluation methods* to test the PL-PD with three groups of stakeholders during four cycles:

Simulations: In order to identify stumbling blocks, I conducted several design simulations. This serves as a first requisite step in a cycle.

Walkthrough: In addition, I conducted several walkthroughs with facilitators (moderator and collaborative learning experts). The aim was to gain insights into improving the process design and determining whether the PL-PD could cope with pedagogical demands and thus, with the generalizable requirements (see section 6.1.5.1). Moreover, the aim was also to identify stumbling blocks in the design of the reference process. The procedures of the walkthrough are depicted in Figure 24.

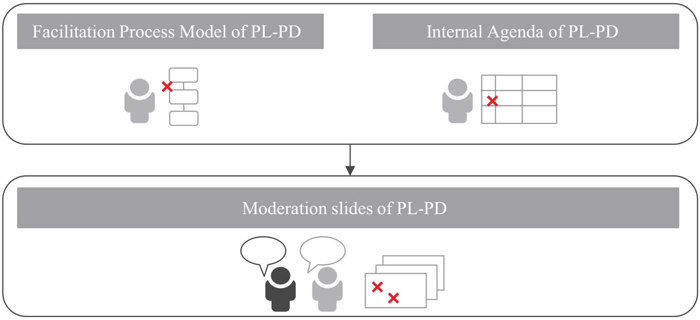


Figure 24: **Procedures of the Walkthrough**
Source: own illustration

First, a facilitator receives two documents. One with the FPM of the PL-PD, and the other one with the internal agenda of the PL-PD. A facilitator examines both documents and marks stumbling blocks. Second, a presentation of the moderation slides and discussion between the collaboration engineer (me) and the facilitator follows. The discussion is led by identifying stumbling blocks in the process design. Semi-structured interview questions underpin the discussion (see Table 37).

Logical structure/Consistency - Where are inconsistencies and stumbling blocks in the design of PL-PD? - How coherent are the collaborative activities with regard to their duration?
Comprehensiveness - How comprehensive are the instructions and tasks that the participants receive? - Do you think the participants will be overstrained to cope with the tasks? - How comprehensible is the documentation of the PL-PD (FPM, internal agenda, moderation slides) for the facilitator?
Formal design development - Does the documentation of the PL-PD cope with formal demands from collaboration engineering? - How do the thinkLets fit to each other? - How far do group products and group activities fit to each other? (input-output relationships between the activities) - How would you evaluate the tool support in the paper-based and in the IT-supported setting of the PL-PD? - How is the coherence of the concept of the PL-PD in general?

Table 37: **Semi-structured Questions during the Walkthrough**
Source: own illustration

Pilot Schemes: By means of two pilot schemes with practitioners (students), I gathered data from a survey as well as a participating observation. The pilot schemes are the application of the PL-PD in a real-world setting in an IS Masters Course with students who collaboratively transferred and documented their acquired knowledge about design methodology in the form of a storyboard. In order to gain insight into how to apply the same PL-PD with different tool support, PL-PD was conducted with paper-based tools, while the PL-PD of the next iteration was conducted with a group support system (GSS), namely ThinkTank, acting as IT-based tool support (see Figure 25). The structure of every pilot scheme comprised a pre-test and a post-test with practitioners attending the PL-PD. In each case, the pre- and post-tests consisted of a knowledge test (true/false questions) and a survey with questions addressing the self-reported knowledge level as well as constructs with items for evaluating the process design from the practitioners'. The ladder constructs were adapted from Briggs et al. (2013). In both settings (paper-based vs. IT-supported) the PL-PD was moderated by using the same moderation slides (see Appendix 1).

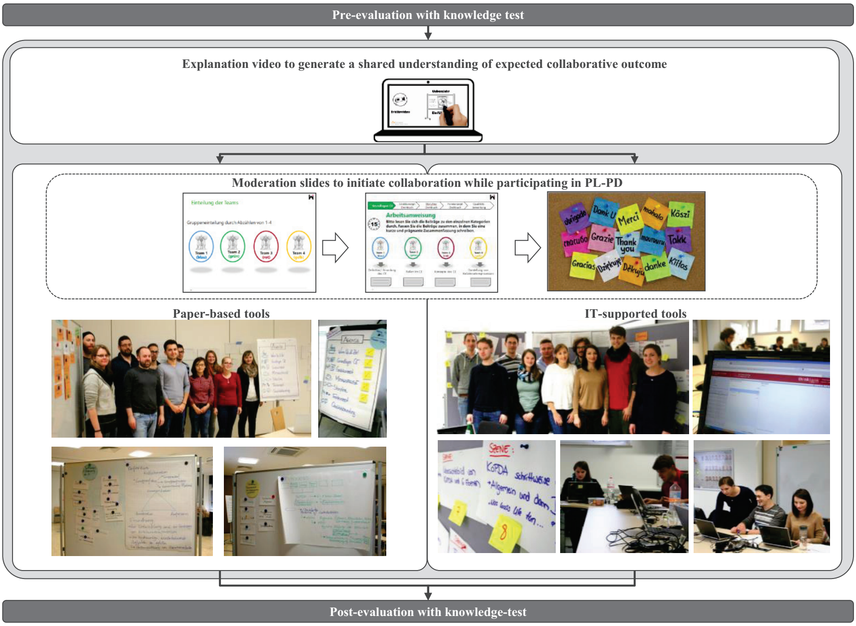


Figure 25: **Procedures of the Pilot Scheme**
Source: own illustration

To investigate findings with regard to the impact to PL-PD collaborative knowledge transfer I used a knowledge test as well as self-reported knowledge measures. To investigate whether the PL-PD packages sufficient collaboration expertise so that the PL-PD can be used with paper-based and IT-supported tools as well, I used satisfaction measures adapted from Briggs et al. (2013). Table 38 describes the measures that I used in the pre-evaluation and in the post-evaluation. For a detailed description of the measures see Appendix 2 for the pre-evaluation and Appendix 3 for the post-evaluation.

Pre-evaluation measures	**Post-evaluation measures**
5-item knowledge test *[true/false]*	5-item knowledge test *[true/false]*
Self-reported level of knowledge *[5-point Likert scale]* - Type of documenting knowledge (storyboard) - Procedural knowledge which becomes transferred	Self-reported level of knowledge *[5-point Likert scale]* - Type of documenting knowledge (storyboard) - Procedural knowledge which becomes transferred
	Type of documenting knowledge (storyboard) - Procedural knowledge which becomes transferred - Satisfaction measures (SO, SP, PROCDIF, TOOLDIF) *[5-point Likert scale]* (Briggs et al. 2013)

Table 38: Measures of the Pre- and Post-Evaluation
Source: own illustration

6.1.6.2 Results

First, I discuss the results of the qualitative data analysis. Second, I refer to the results of the descriptive data analysis.

Analysis of Qualitative Data

In order to analyze the qualitative data that I gathered during the simulation, walkthrough, and observation during the pilot scheme, I use a qualitative content analysis according to Mayring (2004). Figure 26 refers to the qualitative content analysis and depicts the category system of the content analysis. Table 39 illustrates the coding guideline. The category system consists of four main categories. These reflect the four design/evaluate cycles. The subcategories for each iteration loop reflect the quality criteria for evaluating the PL-PD from a facilitator's point of view (Leimeister 2014). To ensure traceability, I developed a coding guideline (Mayring 2004), mainly referring to the quality criteria for evaluating the PL-PD. Accordingly, in every cycle I analyze whether the PL-PD addressed the quality criteria, depicted in Figure 26.

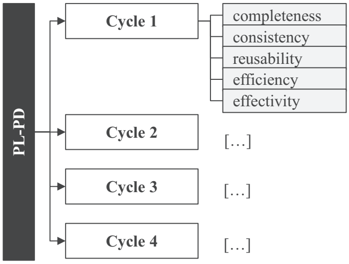


Figure 26: **Category System and Coding**
Source: based on Oeste-Reiß et al. (2016)

Category	Category description: When to code qualitative data into the category.
Completeness	Process is complete if there are no content-specific lacks (e.g. CoPDA and didactical requirements addressed) (Leimeister 2014).
Consistency	Process is consistent if it follows a logical structure, and products as well as activities are not in conflict (Leimeister 2014).
Reusability	Process is reusable if it can be conducted with planned activities by a practitioner leading to equal results (Leimeister 2014).
Efficiency	Process is efficient if there are no alternatives existent to catch collaborative goals and products with less input (Leimeister 2014).
Effectivity	Process is effective if the application leads to achieving the defined collaboration goals (Leimeister 2014).

Table 39: **Qualitative Content Analysis – Coding Guideline**
Source: based on Oeste-Reiß et al. (2016)

In the following, I refer to the most important insights for each cycle: In *iteration cycle 1*, I designed PL activities by using CE mechanisms for the first time. The granularity of activities in version 'V1' was high, because PL activities were designed not by using existing thinkLets. Nevertheless, the results of the simulation cope with the evaluation criteria outlined in Table 39. A judgment on the criteria of reusability was not possible at that time since the PL-PD had not been conducted with practitioners yet. *Iteration cycle 2* inter alia consists of a walkthrough, which disclosed insights on the consistency of the PL-PD. A walkthrough refers to the formation of groups and the wording of the assignments. A facilitator noted *"[…] when do the learners work in groups? […] what shall the learners do for solving an assignment?"* Thus, for 'V2' I refined the comprehensiveness of the wording and the structure of the assignments. Moreover, I reduced the number of changes of group formations. This led to insights on how to tighten the granularity of collaborative activities and thus to design the whole PL-PD by using existing thinkLets. Using existing thinkLets means to ground use in its mechanisms of initiating collaborative activities and to define new assignments with pedagogical guidance. Additionally, the facilitators assumed that the PL-PD was effective as they noted *"[…] it will work and the participants will be excited!*" Within *iteration cycle 3*, the observations during the pilot scheme led to insights into the completeness criteria concerning pedagogical claims for the knowledge transfer. The collaboration between the practitioners was very close and was characterized by active discussions. In *iteration cycle 4*, I changed the tool support and conducted the PL-PD by means of using the GSS ThinkTank. The evaluation criteria were acknowledged. However, the group dynamics changed. The relationship between the facilitator and the practitioners was not as close as in cycle 3. Moreover, the participants had the chance to make anonymous contributions, which in turn led to a few unprofessional contributions from some of the practitioners.

Analysis of Quantitative Data

Table 40 depicts the results of the descriptive data analysis, consisting of a comparison of the pilot scheme results from the iteration *cycles 3* and *4*. The results give insights into how practitioners experience the PL-PD, what their knowledge levels are, and which differences occur when changing the tool support. The results of the satisfaction responses with PL-PD have a high mean on a 5-point Likert scale in both groups. Results are better in the group using paper-based tools as compared to those in the group using IT-supported tools.

		Cycle 3 (Paper) N = 8	Cycle 4 (IT) N = 11
		Mean (SD)	**Mean (SD)**
Satisfaction with PL-PD	SP – Satisfaction with Process	4.33 (0.44)	2.76 (0.87)
	SO – Satisfaction with Outcome	4.35 (0.45)	2.73 (1.23)
	TOOLDIF – Tool Difficulty	4.43 (0.47)	3.73 (0.45)
	PROCDIF – Process Difficulty	3.78 (0.61)	3.38 (0.49)
	5-point Likert scale (1 = negative; 5 = positive)		

Table 40: Results for Satisfaction with PL-PD
Source: based on Oeste-Reiß et al. (2016)

Table 41 compares the results of both groups (paper-based and IT-supported) with regard to the knowledge test performance and the self-reported level of knowledge in the pre- and post-evaluation.

Contrasting the pre-test results with regard to knowledge increases showed no significant differences. The results for the self-reported knowledge level as well as the knowledge test show similar results in both groups. This indicates that the participants started with comparable conditions.

Comparing the pre- and post-test performance showed that the level of knowledge increased in both groups. This indicates that the PL-PD has the potential to enable a knowledge transfer among participants by using paper-based tools as well as IT-supported tools. In both groups, the results of the post-tests are better than those of the pre-tests. Regarding the PL-PD's potential to stimulate knowledge gains, the results from the knowledge tests show a knowledge gain in the post-test as well. Nevertheless, to positively increase the experience of the PL-PD by using IT-supported tools, further adaptations and evaluations are necessary.

	Cycle 3 (Paper) N = 8			**Cycle 4 (IT) N = 11**		
	Pre-test	**Post-test**	**Spread**	**Pre-test**	**Post-test**	**Spread**
	Mean (SD)	**Mean (SD)**		**Mean (SD)**	**Mean (SD)**	
Knowledge test	67% (0.52)	71% (0.64)	↑*4%*	72% (0.52)	76% (0.63)	↑ *4%*
Self-reported level of knowledge						
a.) about kind of documenting knowledge (storyboard development)	2.75 (1.28)	3.88 (0.64)	↑*1.13*	2.10 (0.57)	3.40 (0.84)	↑ *1.30*
b.) about procedural knowledge which becomes transferred	3.13 (0.35)	3.63 (0.52)	↑*0.50*	3.40 (0.52)	3.70 (0.48)	↑ *0.30*
5-point Likert scale (1 = very less; 5 = very high)						

Table 41: Descriptive Statistics for Knowledge Measures
Source: based on Oeste-Reiß et al. (2016)

6.1.7 Discussion

The PL-PD was iteratively refined in several evaluation cycles. Hence, the PL-PD was systematically redesigned. The final PL-PD design contributes to CE literature in the research area of PL. Since the PL-PD design complies with requirements from the body of PL literature it has the potential to leverage the potential of collaborative knowledge transfer among participants from a theoretical point of view. In this study I showed the development and evaluation of the PL-PD as generalizable solution for enhancing collaborative knowledge transfer. The aim was to gain first insights on whether systematically designing PL activities will enhance collaborative knowledge transfer. From that point of view the evaluations in cycles 1 and 2 in particular serve as a proof of concept research. Proof of concept research demonstrates the functional feasibility of a solution. Prototypes such as a first exemplar instance of the PL-PD are not necessarily full featured or stable (Nunamaker Jr et al. 2015). In order to investigate findings for a proof of value from the field with real stakeholders the cycles 3 and 4 provide additional insights. The PL-PD is a new approach for solving the known problem of knowledge transfer. For this reason, I consciously choose the described way of design validation in order to gain deep and rich insights. From a CE point of view, the required PL activities can be designed by combining existing thinkLets. This connotes that PL activities can be developed in order to stimulate knowledge transfer by using CE mechanisms, also implying that requirements from PL can be indicated by means of using CE mechanisms. The reference process of PL-PD uses and combines existing thinkLets to enhance knowledge transfer among the involved participants. Although one could argue that the innovativeness of the solution is small, it should not be underestimated that a reconfiguration of existing established collaborative techniques took place with the PL-PD's process design and the structure of setting and by defining collaborative learning tasks.

Design Goal 1 – Leverage the power of collaborative knowledge transfer to enhance knowledge increases among the learners

Table 41 depicts the PL-PD's potential to stimulate knowledge transfer and to increase knowledge gains. There is a gain of practitioners' knowledge in both offline and online settings. Comparing the pre- and the post-tests, iteration cycle 3 indicates an increase in the knowledge test results from 67% to 71%, compared to an increase from 72% to 76% in cycle loop 4. Furthermore, I asked the practitioners about their self-reported level of knowledge. I used a differentiated question, since the collaboration would result in a knowledge gain addressing procedural knowledge, whereas the type of knowledge documentation in the form of a storyboard would be something new for some practitioners. Similarly to the results of the knowledge test, the results for the self-reported level of knowledge also increased. The increase in both the knowledge test results and the self-reported level of knowledge results on procedural knowledge indicates that the practitioners experience the collaboration during the PL-PD as to be valuable and that their self-assessment is, in fact, correct.

Design Goal 2 – Package Sufficient Collaboration Expertise in the Design of the PL-PD so that it can be Executed with and without IT Tool Support

In order to investigate findings for the reusability of PL-PD I used well-established satisfaction measures adapted from Briggs et al. (2013). A resulting benefit is the reusability of the PL-PD with different tool support. I analyzed the applicability of the same PL-PD with changes in the tool support from a practitioners' as well as from a facilitators' point of view. A comparison of the results for knowledge transfer between cycle 3 (paper-based) and cycle 4 (IT-supported) showed that an IT-supported collaboration leads to approximately the same results (see Table 40). But the practitioners using paper-based tools in cycle 3 are more satisfied with the process and the outcome and are more comfortable with the tools and the process difficulty. During the execution the group dynamics differed. Possible explanations for that phenomenon are:

- *Relationship between facilitator and practitioners:* The group atmosphere was different. The relationship between the facilitator and the practitioners occurred to be closer in the group that followed a paper-based PL-PD than in the group that followed an IT-supported PL-PD. An explanation might be the different tool support that required a different frequency of interactions between the facilitator and the practitioners. The interaction in the group with paper-based tool support was higher, since the facilitator had more direct interactions with the practitioners, e.g., place cards and flip charts. The GSS took over these activities in the other group and the frequency of direct interactions between the facilitator and the practitioners decreased. The GSS replaced some of the instructions and moderating activities and practitioners worked more independently. This might have led to negative effects in terms of perceived satisfaction with the process and outcome. A lesson learned is that the facilitator has to look for other entry points in order to interact directly with the practitioners and to generate a positive group atmosphere.

- *Anonymity of making contributions and relationship between practitioners:* In the online setting, the GSS allowed practitioners to make anonymous contributions. This led to a couple of unprofessional contributions, which interrupted the process flow and the relationship between the practitioners. A lesson learned is that contributions in the GSS should not be anonymous in order to ensure accountability of practitioners' work and to avoid inappropriate contributions.

Nevertheless, there is an increase in the results for the knowledge transfer within the iteration cycles that sticks to a high level for both offline and online settings. This leads to the assumption that the same PL-PD is applicable with different tool support. Since the results for the PL-PD in the group that had paper-based tool support are better than in the group with IT-supported tools, I recommend expansions in the internal agenda for future research. The instructions for the facilitator need to be different. A section with differentiated instructions for enhancing a positive group atmosphere with a close relationship between facilitator and practitioners as well as among practitioners would be of value.

6.1.8 Limitations and Future Research

This study is not without limitations; but if offers valuable insights on designing innovative solutions and gaining first insights. Based on the results of PL-PD I provide follow-up studies that are described in the following chapters of my thesis. In addition, I discuss the limitations of the current study in the subsequent paragraphs and describe entry points for future research.

- *Applicability of the PL-PD in organizations:* For the pilot scheme evaluation of the PL-PD I used a university setting. Thus, students participated in the PL-PD and not employees from a company. Even though the pilot schemes with students underlie similar conditions as in an organizational setting. Future research therefore should evaluate the value of the PL-PD in an organizational setting. In my evaluation, practitioners, namely students, had comparable levels of knowledge. Participating in the PL-PD led to a knowledge increase, even among practitioners on similar levels of knowledge. An evaluation with strong differences in the levels of knowledge of the practitioners, including more knowledgeable experts and less-knowledgeable as novices, would allow a more detailed analysis of the resulting knowledge transfer.

- *Transferability:* Students from a small master's course served as participants in the pilot scheme. As a consequence, the population of participants in the pilot schemes is small. Even though the usage of IT support provides first insights into the transferability of PL-PD, there are some other aspects that should be addressed to strengthen the findings of the current study on transferability. Therefore, follow-up studies should evaluate PL-PD's transferability in different ways:

(1) An execution of a PL-PD in a large-class setting might lead to broader findings with regard to its transferability. A larger N will help to strengthen the results when it comes to leveraging the power of knowledge transfer and to increasing the level of knowledge among the participants. Knowledge measures among participants are important indicators for knowledge transfer. Therefore future research should focus on a broader analysis on the effects of LLL and HLL on the participants. Future research should also address a deeper analysis of the knowledge documents since this will also bring insights for increases in HLL. In chapter 6.3 of my thesis I will therefore present a study that develops a reference-process for HLL in large classes with special emphasis on the effects of knowledge increases among the participants.

(2) Besides the execution of PL-PD in large classes, transferability will also occur by transferring the PL-PD to practitioners in the role of a facilitator and empowering them to conduct the PL-PD with participants that achieve comparable results. For that reason future research should focus on the conduction of a reference process by different facilitators. In chapter 6.2 of the thesis I present a study that empowers lecturers to conduct the same reference-process design with comparable results.

- *(Indirect) knowledge transfer to third parties:* Finally, the focus of this study was not to evaluate the indirect knowledge transfer to third parties. Thus, future research should assess the suitability of resulting knowledge documents for an indirect knowledge transfer to people who did not participate in a PL-PD.

6.1.9 Conclusion and Contribution

In this study, I reported findings on how to design a PL-PD to leverage the power of knowledge transfer that is applicable with different tool support. The overall research approach is embedded in DSR. I derived a working definition of knowledge transfer and justified PL as a crucial basis for knowledge transfer activities. Based on theory, I identified generalizable requirements from the body of PL literature and used the CoPDA as a design methodology for developing the PL-PD. For the evaluation and refinement of the PL-PD, I conducted four iterative design/evaluate cycles and used different methods to validate the PL-PD: simulations, walkthroughs, and pilot schemes. The results show that the PL-PD considers pedagogical requirements. It is applicable with and without IT support and leverages collaborative knowledge transfer.

The results contribute to theory and practice. They provide principles of form and function inherent in the generalizable requirements for designing collaborative processes to stimulate knowledge transfer (see section 6.1.5.1) and the description of PL-PD as generalizable solution (see section 6.1.5.2). I showed that PL activities can be designed in a reusable way by structuring learning activities and assignments. Furthermore, the PL-PD gives insights into conducting the same process design with different tool supports. From that point of view the PL-PD represents prescriptive knowledge and can be classified as a contribution of the type 'improvement' (Gregor/Hevner 2013). This way, the PL-PD resembles a component of a nascent design theory (Gregor/Hevner 2013). It is a new solution, since it uses process restrictions and established collaboration techniques to enhance PL activities in order to stimulate collaborative knowledge transfer. From that point of view it represents the application of CE mechanisms in a new domain – the domain of learning. Moreover the solution of PL-PD is new, since it also packages PL expertise in its process design.

6.2 Peer-Learning Pattern Approach for Empowering Lecturers to Enhance Collaboration among Learners in the Disciplines of Problem-Solving and Critical Thinking Regardless of Class Size[9] (PL-PA)

6.2.1 Peer-Learning Pattern Approach in the Context of the Thesis

In chapter 6.2 of my thesis I will address RQ 3b:

> What are characteristics and effects of peer-learning reference processes? *(Design, implementation, evaluation)*
>
> ➔ RQ 3b: How can peer-learning knowledge be packaged in a reusable design that comprises sufficient collaboration techniques to empower lecturers (and learners) to conduct (and to follow) HLL activities in the classroom?

Answering RQ 3b serves as a proof of value of systematically designed PL activities. As the findings from the studies discussed above show, transferability of PL activities constitutes still a challenge. Even though the previous study addressed transferability with regard to conducting a reference process for enhancing PL activities by using IT-supported tools, it is important to address transferability from a moderator's point of view. Against that background it is important to gain insights into how different moderators are able to conduct the same reference process and achieve comparable results among the participants. The previous study shows that it is possible to design PL activities in a reusable and structured way. Thus, to restrict learners in their learning experience is not a disadvantage. More precisely, learners are also able to achieve knowledge gains. With this in mind, the current study focuses on transferability aspects with regard to empowering lecturers to conduct the same reference process and achieve comparable results among the participants.

From a practical point of view the typical duration of e.g. a university class lesson is approximately 2 hours. In contrast, the PL-PD from the previous study had a long duration. For that reason it is important to find opportunities to modularize the first

[9] The insights presented in this chapter are based on two publications on this topic: (Oeste-Reiß/Bittner/Söllner 2017) and (Oeste et al. 2015a). I thank my collaborators, reviewers and attendees of the AoM Meeting 2015 and the WI 2017 for their valuable feedback on my work. Many thanks for the captivating discussions to the attendees of the "PDW-Management Education and Learning Writers Workshop [AoM Meeting 2015]" in Vancouver, BC, Canada. I also thank all the participants for participating in the evaluation of PL-PA during the several walkthroughs and pilot schemes.

reference process of the PL-PD and to identify smaller reference processes for specific PL activities that can be combined with each other or used on their own.

For that reason I present the design and evaluation of the Peer-Learning Pattern Approach (PL-PA) in the current study. I describe a DSR project according to Gregor and Hevner (2013). The PL-PA comprises two small reference processes that serve as building blocks: a pattern for enhancing problem-solving activities and a pattern for enhancing critical thinking activities. The results show that different lecturers are able to conduct the process design and evoke comparable results among learners. In the evaluation I report and compare the results from different treatments. Different lecturers conducted the PL-PA in the same master's course at a German and a Swiss university.

6.2.2 Study Outline and Research Approach

Fostering higher-level learning in the disciplines of problem-solving and critical thinking becomes important when educating knowledge workers. By taking part in PL activities, e.g., interactive discussions, learners have the chance to develop, defend, and critique positions. However, implementing PL activities is often complex because this requires knowledge in designing effective collaboration. I build on insights from learning and CE literature to develop an IT-based PL-PA that consists of two patterns, each describing a process design – one for training problem-solving, and the other for attaining critical thinking abilities. To evaluate the PL-PA, I use simulations, walkthroughs among lecturers, and pilot schemes among students. Results show that the PL-PA empowers lecturers to implement respective activities in the classroom, takes into account pedagogical demands, and satisfies lecturers as well as learners. I contribute several findings toward a design theory for empowering lecturers to implement PL activities in their classes.

In this study, I describe a DSR project and structure the current chapter along Hevner's (2007) three-cycle view (Figure 27). First, I start the relevance cycle by identifying a set of unsolved problems inherent in packaging sufficient collaboration expertise to empower lecturers for enhancing PL activities for HLL in the classroom (activity #1 | section 6.2.3). Second, I initiate the rigor cycle by drawing on justificatory knowledge from learning literature with respect to training problem-solving and critical thinking abilities (activity #2 | section 6.2.4). Thirdly, I start the design cycle and provide principles of form and function inherent in generalizable requirements for empowering lecturers to enhance PL activities for HLL, and the PL-PA design with its two patterns as a generalizable solution (activity #3 | section 6.2.5). Fourth, I complete several iterative design and relevance cycles by describing the procedures of testing three iterative exemplary instances of the PL-PA in terms of a multi-method evaluation (activity #4 – simulation with designers │ activity #5 – walkthrough with lecturers │ activity #6 – pilot scheme with students in the classroom │section 6.2.6). The results show that the designed artifact of the PL-PA meets the design goals. In section 6.2.7, I complete the rigor cycle by adding prescriptive knowledge[10] (Gregor/Hevner 2013) to the literature before I close with an outlook on future research in section 6.2.8. According to Gregor's (2006) descriptions, my PL-PA resembles a theory of 'design and action'. More precisely, it is of the type 'improvement'. Lecturers can use this PL-PA to create their own exemplary instances of PL-PA (Gregor/Hevner 2013).

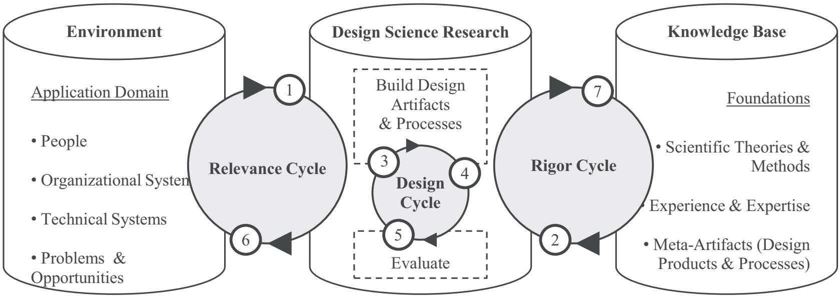


Figure 27: DSR Three-Cycle View in the Context of the Study
Source: based on Oeste-Reiß et al. (2017) adapted from Hevner (2007)

6.2.3 Problem Statement and Design Goals

Approaches for training higher-level learning on the upper levels of Bloom's revised taxonomy (apply, analyze, evaluate, create) (Krathwohl 2002) in the disciplines of problem-solving and critical thinking are becoming increasingly important in the digital age, which is characterized by an increasing availability of information. Competences such as teamwork and communication abilities are highly relevant as well (Chiru et al. 2012). The performance of knowledge workers depends on the degree to which they master those skills. Thus, universities have to provide learning experiences that help learners to develop those skills. However, traditional lectures – characterized by a low level of interaction among learners and a focus on factual knowledge (Oeste et al. 2014) – are still popular. The reasons are for example declining state funding and increasing

[10] *Prescriptive knowledge* describes artifacts designed by humans to improve the natural world. It is inherent in the form of models, methods, instantiations, and design theories (Gregor/Hevner 2013) (see section 3.2.3).

student numbers (Ma et al. 2015). This means that learners often lack the chance to develop, defend, and critique positions, which would be vital for achieving HLL.

PL approaches ground on insights from constructive learning theory that posits that learning occurs by experiencing an environment through interactions with other individuals (Jones/Brader-Araje 2002). These approaches seem to be promising when it comes to overcoming existing shortcomings. However, PL approaches that focus on HLL are typically less predictive and hardly replicable, demand an understanding of how to design effective collaboration, and do not restrict learners in their experiences (Dillenbourg 2002). Lecturers lack validated out-off-the-box techniques to conduct and stimulate PL activities among learners. While lecturers struggle with less predictive and hardly replicable learner interactions and outcomes, learners struggle with PL techniques in terms of HLL tasks. These tasks provide learners with a problem situation. Such situations require that learners develop a solution that represents a sophisticated understanding of knowledge concepts and their relationships and thus, train problem-solving abilities. Furthermore, these situations require that learners analyze and evaluate the situation and, thus, train critical thinking abilities. Inexperienced learners that are not familiar with these HLL learning techniques are often overstrained since e.g. tasks seem to be unclear and open-ended and instructions focus on learning content, but often do not provide training or guidance on how to proceed through the PL experience for achieving HLL effects.

In contrast to constructivist learning literature that argues learning processes should be ad hoc (Dillenbourg 2002; Kollar/Fischer/Hesse 2006), collaboration literature shows that process structures can under certain conditions increase the number, quality, and creativity of ideas a group creates. They may also increase the number of communication cues exchanged within a group, and improve the quality of its work products while reducing cognitive load (Briggs et al. 2013). Most individuals – lecturers as well as learners – do not have an intuitive grasp of effective collaboration. In cases of inventing ad hoc collaboration, most groups tend to be ineffective (Briggs et al. 2013). This leads to the assumption that PL experiences may benefit from systematically designed collaboration that guides lecturers and learners.

Therefore, applying insights from collaboration literature to the domain of learning might be a solution. Therefore, a design methodology is needed that

a) provides procedural guidance on how to split structure and that describes PL activities for HLL in a way that helps lecturers and learners proceed through PL activities in a predictive and effective way; and

b) helps lecturers implement PL activities for HLL as building blocks in their classes.

In that context, CE is an approach that designs and deploys high-value recurring tasks and transfers them to practitioners (lecturers, learners) without the ongoing support from expert facilitators (Briggs et al. 2013).

The goal of this study, therefore, is to help lecturers and learners overcome this challenge by answering the following research question:

How can peer-learning knowledge be packaged in a reusable design that comprises sufficient collaboration techniques to empower lecturers (and learners) to conduct (and to follow) HLL activities in the classroom?

I focus on these two patterns for two reasons. First, they enhance cognitive processes that refer to applying, analyzing, evaluating, and creating knowledge, and thus focus on the upper levels of Bloom's revised taxonomy (Krathwohl 2002); and second, they help enhance skills relevant for knowledge workers such as teamwork and communication. Each pattern represents a design for a reusable and structured collaboration process that packages sufficient collaboration expertise so that non-experts (lecturers, learners) can execute and follow a well-designed work practice without training in tools and techniques. I follow the idea of patterns, because patterns "[…] exist as a means of deriving useful solutions to recurring problems within specific contexts" (Petter/Khazanchi/Murphy 2010). Consequently, a pattern describes a recurring problem as well as the core of the solution for that problem in such a way that the solution can be used unlimitedly (Petter/Khazanchi/Murphy 2010).

The objective of this study is to develop the PL-PA comprising two reference-process designs inherent in patterns for enhancing HLL – the Problem-Solving Pattern (PSP); and the Critical Thinking Pattern (CTP).

The design goals of the PL-PA are:

- *Design Goal 1: Help lecturers enhance PL activities for HLL in the areas of problem-solving and critical thinking in classes in a predictive way;*

- *Design Goal 2: Help learners proceed through PL activities with assisting guidance on collaboration.*

6.2.4 Theoretical Foundations of Problem-Solving and Critical Thinking

PL is based on constructivist learning theory (Topping 2005) and learners that learn from experiences that they gain through interactions with their environment and each other (Moll 2013). If well designed, PL may relieve the lecturer from some labor-intensive tasks, particularly in large classes, such as giving individual feedback on assignments. Learners benefit from such interactions in several ways: e.g. discussions can enable a direct exchange between learners that fosters reflection of knowledge, and thus, critical thinking; and can increase motivation, participation (Eisenkopf 2010), and learning success (Moore/Kearsley 2011). This helps learners improve job-relevant competences like teamwork and communication (Topping 2005). The range of PL activities comprises discussions, co-construction of solutions, or giving mutual feedback. Literature on peer discussion of multiple-choice tasks, for example, describes positive learning effects when learners first reflect knowledge on their own, then discuss their choice with others, and finally re-evaluate their choice (Jones 2014). The co-construction of a solution, for example, helps learners explain ideas to each other, challenge each other, and stimulates knowledge creation (Wegener/Leimeister 2012). Moreover, mutual assessment among learners has the potential to correct mistakes and to clarify unclear issues (Parece/Mulder/Baik 2009).

To enhance such PL experiences, lecturers need to respect several aspects. They have to ensure reciprocity in social interactions among learners, e.g. when it comes to direct feedback (Harris 1998). They also have to ensure that learners are responsible for their outcome (Wegener/Leimeister 2012) and that assignments and instructions are clear (Hall/Stegila 2003). In a class, however, there are high- and less-experienced learners. Hence, it is hard for a lecturer to create a learning experience that challenges the top learners without losing the bottom learners. A shared understanding of knowledge concepts therefore is necessary to foster social interactions toward a development, modification, and reinforcement of shared mental models (Mohammed/Dumville 2001). Van den Bossche et al. (2010) identify team learning behaviors as follows:

- learners should express and share their individual understanding, and listen to each other (construction) (Bossche et al. 2010),

- discuss and clarify their understanding to reach mutual understanding (co-construction) (Bossche et al. 2010),

- and negotiate an agreement on a mutually shared perspective (constructive conflict) (Bossche et al. 2010).

Problem-based learning is known to help learners achieve HLL effects. This is focused experiential learning that is organized around the investigation, explanation, and resolution of meaningful problems (Barrows 1986). This way it refers to metacognitive knowledge on the upper levels of Bloom's revised taxonomy (Krathwohl 2002). Learners collaborate in small groups and solve a problem. Depending on the assignment, the learners train problem-solving abilities by creating a common solution for a complex situation. They can also train critical thinking abilities by evaluating, analyzing, interpreting or explaining a problem situation with the aim of making a reflective judgement (Facione 1998). The lecturer facilitates and guides learners through the learning experience (Hmelo-Silver 2004). Although a wide range of variations of problem-based learning have evolved in literature and educational practice, there are some core characteristics:

(1) learning needs to be learner-centered (Barrows 1986);

(2) learning has to occur in small groups under the guidance of a tutor (Barrows 1986);

(3) the tutor needs to act as a facilitator (Barrows 1986);

(4) authentic problems are primarily encountered in the learning sequence, before a preparation has occurred (Barrows 1986);

(5) the problems encountered are used as a tool to achieve knowledge and skills that are necessary for problem-solving (Barrows 1986).

Fifty years after problem-based learning had evolved; it was applied to various educational contexts. Much evidence suggests that it is more effective than traditional methods with regard to enhancing learners' problem-solving and critical thinking abilities. However, skeptics argue that it is ineffective because it provides only minimum guidance and therefore is too complex and not compatible with human cognitive architecture (Kirschner/Sweller/Clark 2006). From a meta-study, Hmelo-Silver 2004 (2004) derives a research agenda that calls for more work in the areas of collaboration, scaffolding structures for inexperienced learners, and approaches to overcome the lack of skilled facilitators. "Classrooms have more students than one person can easily facilitate, and learning to facilitate well is a challenge" (Hmelo-Silver 2004). She suggests techniques such as procedural facilitation or scripted cooperation to address this challenge.

6.2.5 The Peer-Learning Pattern Approach

6.2.5.1 Generalizable Requirements to Empower Lecturers for Stimulating Peer Learning

Starting with the generalizable requirements, I follow the DSR paradigm. I derive generalizable requirements (see Table 42) to design PL activities for HLL by completing a relevance cycle (section 6.2.3) and a rigor cycle (section 6.2.4).

Relevance cylce – lecturers' requirements (see the specific challenges/sources in brackets):	
GR 1	*Set-up Guidance:* The PL-PA shall provide instructions for the task choice, as well as definition, set-up, and configuration of PL activities (lack of PL design experience of lecturers).
GR 2	*Facilitation Guidance:* The PL-PA shall provide detailed instructions on the facilitation actions, e.g. statements and questions the lecturer needs to work with during the PL experience (unpredictable moderation of PL).
Relevance cylce – learners' requirements (see the specific challenges/sources in brackets):	
GR 3	*Simplified Process Structure:* The PL-PA shall divide PL into activities with defined subtasks (learners' resistance to open-ended and highly complex task structures).
GR 4	*Collaborative Interaction Support:* The PL-PA shall provide instructions on how interactions among learners should be organized in each phase (high cognitive load because of inventing ad hoc collaboration parallel to task solving).
GR 5	*Clear Goal/Outcome Specifications:* The PL-PA shall define clear final and intermediate goals and outcomes for the learners for a specific task (risk to self-efficacy and satisfaction in case of transparency).
Rigor cycle – collaborative learning literature:	
GR 6	*Individual Reflection:* The PL-PA shall support individual construction and reflection of knowledge (Bossche et al. 2010).
GR 7	*Mutual Feedback:* The PL-PA shall provide structured support for constructive feedback, sense making (Parece/Mulder/Baik 2009; Bossche et al. 2010).
GR 8	*Consolidation of Solutions:* The PL-PA shall provide structured support for negotiating and consolidating different perspectives towards a shared solution (Hall/Stegila 2003; Bossche et al. 2010).
GR 9	*Access to Solution:* Exemplary solutions shall be provided to all learners or discussed after the task completion (given the partly unpredictable outcome of PL, all learners shall have the chance to receive a correct solution) (Wegener/Leimeister 2012).
GR 10	*Task Responsibility in Small Breakout Groups:* The PL-PA shall assign distinct, complementary subtasks to breakout groups small enough for each learner to feel responsible for the result (Harris 1998; Wegener/Leimeister 2012).

Table 42: Generalizable Requirements for Empowering Lecturers to Enhance PL
Source: based on Oeste-Reiß et al. (2017)

6.2.5.2 The Peer-Learning Pattern Approach as Generalizable Solution

The aim of the PL-PA is to initiate predictive small-group PL activities for helping learners to achieve HLL effects in the disciplines of problem-solving and critical thinking. Thus, the PL-PA comprises two patterns:

- *Problem-Solving Pattern (PSP)*: see corresponding paragraph and Table 44,

- *Critical Thinking Pattern (CTP):* see corresponding paragraph and Table 45.

To develop and describe the PL-PA I use the Six-Layer Model (Briggs et al. 2014a) as a design methodology in order to apply insights from CE literature, such as process restrictions and structuration of collaboration, to the domain of PL (Briggs et al. 2014a). By following the layers I systematically derive a reusable process design for each pattern that structures PL in a sequence of activities with several outcomes. The generalizable requirements guide my design choices. I describe the patterns in the form of an internal agenda (moderation plan) that inter alia illustrates the group goal, products, and the sequence of PL activities.

General Conditions of the Peer-Learning Pattern Approach

However, to conduct the two patterns of the PL-PA in a transferable manner, lecturers have to meet some conditions (see Table 43) to build their own exemplary instance of a PL-PA. Table 43 describes these conditions:

Conditions	Description
Problem situation	Define an overall complex problem situation with action items in which the subtasks become embedded. A problem situation is a situation that covers the intended content to be learned as well as the specific and unique contextual factors to be considered, and that considers the conceptual connections of the problem within the curriculum (Hung 2009).
Choose and create task structure	Define 2 up to 15 independent subtasks that refer to learning objectives (task specifics described in each pattern); pay attention that its execution takes place in parallel subgroups/breakout groups.
Specify deliverables	Realize learning objectives within the demands of the group deliverable (e.g. visualization and explanation) and pay attention to the fact that it is easy to present in the plenary group.
Breakdown group structure	The whole class is the plenary group. A plenary group can be divided into at least 2 up to 15 subgroups (4 to 30 participants each), working simultaneously. A subgroup can be divided into several breakout groups (2 to 6 participants each) (Gallupe et al. 1992).
Dependencies groups and tasks	Each participant is part of a breakout group and works on a specific subtask (number of subtasks = number of breakout groups). A subgroup receives all subtasks.
Transferability to tools and group size	The problem situation and its subtasks can be assigned to more than one subgroup and their breakout groups. Use tools that provide a shared working space for all breakout groups.

Table 43: **General Conditions to Build an Exemplary Instance of PL-PA**
Source: based on Oeste-Reiß et al. (2017)

Problem-Solving Pattern (PSP)

The *group goal* of PSP is that learners simultaneously and collaboratively clarify, discuss, and develop a solution for a subtask within two hours. By developing a solution in this way, they train HLL in the discipline of problemsolving, teamwork and, communication abilities. To keep learners motivated, the task should be appealing to them, e.g. by being relevant for learners' future career or addressing their personal interests (Hung 2009). The collaboration helps learners to satisfy individual goals such as becoming qualified knowledge workers by experiencing HLL in the discipline of problem-solving as well as training teamwork and communication abilities.

To operationalize the goal I use an instrumental *group product*: each subtask solution has to be reported as a group deliverable in the form of text and visualizations to illustrate all relevant knowledge concepts and their relationships in a correct and abstract manner and thus, new knowledge is created.

To operationalize the group product I define *group activities* to structure the collaboration. The PSP comprises three distinct steps, each using a thinkLet to structure group activities. While the learners work in a subgroup in step 1, they collaborate within breakout groups in steps 2 and 3.

- In *step 1*, each learner receives access to all subtasks. On their own, learners brainstorm solution ideas while having the chance to read the contributions from their teammates. This activates chunking and thus, cognitive mechanisms to build relationships among knowledge frames. Reading ideas from other learners triggers cognitive effects among the less-experienced learners.

- In *step 2*, learners are assigned to breakout groups, each of which receives a subtask with the deliverables from step 1. In the breakout groups, learners discuss, organize, and summarize contributions and add missing knowledge aspects. This helps them consider and juxtapose the knowledge to create a solution for a problem situation.

- In *step 3*, learners report the solution by using text descriptions and visualizations.

The *tool support* provides shared writing pages (e.g., GSS with separated groups, text editing, visualizations [e.g., ThinkTank, Google Docs, Google Slides]; flip charts; cards) so that the learners are able to make contributions while reading the contributions from other learners (step 1), and to discuss with other learners and visualize their solution (steps 2, 3). After each step the tools generate a report of the group deliverables (e.g. list of ideas).

The *group behavior* restricts learner interactions toward solving the task. After each step, learners are stopped from editing documents and become automatically assigned to their group (plenary group, subgroup, or breakout group). Learners receive guidance via clear instructions, enabling them to cope with subtasks, showing them how to complete the activities, and giving them orientation, e.g. with a list of teammates. Table 44 illustrates the PSP and serves as a moderation plan.

Learning objective	Apply, analyze, evaluate, create	**Task specification**	Content, context, connection
Individual goal	Training HLL in the discipline of problem-solving and, teamwork and, communication abilities.		
Group product	For each subtask a solution in the form of meaningful text and visualizations (e.g., storyline/scenes, slide show).		
Group changes	2: subgroup to breakout group; breakout group to plenary group		
Tool support	GSS – functionalities for separate groups, text editing, visualizations: e.g., ThinkTank, Google Docs, flip charts, cards		

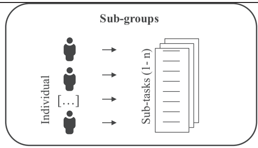
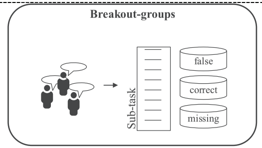
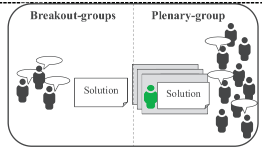
		Group activity & general description	**Group product & quality indicator**	**Group procedures (thinkLet, pattern of collaboration)** (Briggs et al. 2013)
Step 1: 20 min		<u>Subgroups</u>: Each subgroup receives all subtasks. Each learner brainstorms ideas to create a solution for a problem situation among all subtasks.	<u>Product</u>: Per subgroup, a document with a set of solution ideas for each subtask. <u>Quality</u>: Contributions are solution ideas that represent knowledge concepts in the form of meaningful keywords.	<u>*LeafHopper (brainstorm):*</u> For each subgroup a bundle of shared writing pages, each with a subtask. a) Explain learners the subtasks and how to contribute. b) Explain expectations regarding quality aspects of contributions. c) Prompt learners to work on subtasks in which they have the most expertise; to look at each subtask, read it, and add contributions. d) Indicate that learners will not be able to work on every subtask during the available time.
Step 2: 40 min		<u>Breakout groups</u>: Subgroups are divided into breakout groups, each assigned to a subtask. Learners discuss, organize, and summarize solution aspects for a subtask.	<u>Product</u>: Per breakout group, a document with a clarified and summarized set of solution aspects for each subtask. <u>Quality</u>: Organized, corrected, and completed solution aspects.	<u>*PopcornSort (organize):*</u> For each breakout group a shared writing page with a subtask. a) Explain and verify instructions and converge categories (not relevant, correct, missing aspects). b) Explain that contributions are to be assigned to categories. c) Summarize the correct aspects in a meaningful explanation.
Step 3: 60 min		<u>Breakout groups</u>: Learners report their solution in the form of text and visualizations. <u>*Plenary group:*</u> Lecturer and learners discuss exemplary solutions.	<u>Product</u>: Per breakout group a report for a subtask in the form of text and visualizations. <u>Quality</u>: Report comprises all relevant knowledge concepts in the form of text and meaningful visualizations.	<u>*BucketBriefing (clarify):*</u> For each breakout group a shared writing page for text and visualization. a) Explain that learners are to work on the shared writing page. b) Explain to learners quality criteria to report the solution. c) Explain that discussion of exemplary solutions after the remaining time within the plenary group takes place.

Table 44: Problem-Solving Pattern (PSP): Overview and Moderation Plan
Source: based on Oeste-Reiß et al. (2017)

Critical Thinking Pattern (CTP)

The *group goal* of the CTP is that learners simultaneously and collaboratively correct and improve an existing solution from a subtask within two hours. The collaboration helps them to achieve HLL effects in the discipline of critical thinking as well as teamwork and communication abilities.

Typically, abstract solutions of HLL knowledge look professional, complex and thus, seem to be correct. Hence, the *group product* is an improved solution comprising text and visualizations for each subtask. This leads to subtasks that constitute sample solutions that challenge the learners in a way that HLL on the upper levels of Bloom's revised taxonomy (analyze, evaluate, create) will be addressed.

To operationalize the group product I define *group activities* to structure the collaboration. The CTP comprises three distinct steps, each using a thinkLet to structure group activities to improve an existing solution. While the learners work within a subgroup in step 1, they collaborate in step 2 and rate their results individually in step 3.

- In *step 1*, each learner receives access to the existing solutions of all subtasks. On their own, each learner analyzes all provided solutions, marks mistakes, and makes notes for improvements.

- In *step 2*, learners are assigned to breakout groups. Each receives a subtask solution with a list of marked mistakes and improvements. Within breakout groups learners evaluate, interpret, and explain the solutions. They clarify improvement suggestions and write down a revised solution in the form of text and visualizations. A member of each breakout group presents the revised solution to the subgroup.

- In *step 3*, learners evaluate on their own whether the solutions of the subtasks are correct and whether they are satisfied with it.

The *tool support* in steps 1 to 3 provides similar collaborative working spaces as the PSP with shared writing pages. Here, learners can mark mistakes (step 1), create a revised solution (step 2), and rate the revised solutions (step 3). After each step the tools generate a report of the current deliverables of the step (e.g. list of mistakes). The group behavior is restricted toward a focused collaboration like in the PSP. Table 45 illustrates the CTP and serves as moderation plan.

Learning objective	Analyze, evaluate, and create.	**Task specification** Content, context, connection, appeal to learners. Subtasks are exemplary solutions with mistakes.
Individual goal	Training HLL in the discipline of critical thinking, and teamwork and, communication abilities.	
Group product Group changes	Correct and abstract solution in the form of text and/or visualization. 1: subgroup to breakout group	
Tool support	GSS – separate groups, text editing, visualizations, voting: e.g., ThinkTank, Google Docs; flip charts, post-its, cards	

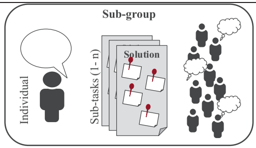
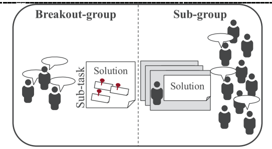
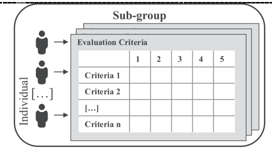
		Group activity & general description	**Group product & quality indicator**	**Group procedures** (thinkLet, PoC) (Briggs et al. 2013)
Step 1: 30 min		<u>Subgroup</u>: Presentation of the solution of all subtasks and identification of mistakes and inconsistencies.	<u>*Product*</u>: Per subgroup, a list with identified mistakes and suggestions for improvements for each subtask. <u>*Quality*</u>: Each mistake comprises a constructive suggestion for improvement.	<u>*BucketWalk (evaluate):*</u> For each subgroup a bundle of shared writing pages, each with a subtask solution. a) Learners read and walkthrough the subtask solutions. b) Learners mark aspects that are: false/not relevant, redundant/inconsistent, poorly formulated. c) Learners write down suggestions for improvements (e.g., better formulation, correct knowledge concepts).
Step 2: 80 min		<u>*Breakout group & subgroup*</u>: Correction of mistakes and inconsistencies. Finalization of correct solution and its presentation.	<u>*Product*</u>: Per breakout group, revised mistakes and inconsistencies of the solution. <u>*Quality*</u>: Revised solution comprises all relevant knowledge concepts in form of text and meaningful visualizations.	<u>*BucketBriefing (clarify):*</u> For each breakout group a shared writing page for a subtask. a) Learners discuss and clarify marked mistakes and improvement suggestions. b) Learners write down a revised solution for their subtask. c) A member of each breakout group presents revised solution in front of the subgroup (max. 5 min).
Step 3: 10 min		<u>*Breakout group*</u>: Assessment of the final solution by learners.	<u>*Product*</u>: Per breakout group, a rated solution of every subtask. <u>*Quality*</u>: Positive values for correctness and satisfaction with the revised solutions.	<u>*MultiCriteria (evaluate):*</u> For each breakout group a shared voting page, each for a subtask. a) Post a list of evaluation criteria (level of correctness, level of sophistication, satisfaction with revised solution) for each subtask solution. b) Learners rate each subtask solution on a scale from 1[very bad] to 7 [very good].

Table 45: Critical Thinking Pattern (CTP): Overview and Moderation Plan
Source: based on Oeste-Reiß et al. (2017)

6.2.6 Validating the Peer-Learning Pattern Approach

6.2.6.1 Methodology

I started in 2014 and iteratively designed and evaluated the PL-PA using a mixed method approach. This is in line with validating collaborative work practices that base on CE and thus, to evaluate whether I achieved the design goals (Leimeister 2014) (Table 46). Table 46 summarizes the data collection methods of the current study.

	Iterative evaluations	1st	2nd	3rd
Qual. data	*Simulation* [requirement-based evaluation] (by designer)	N = 1	N = 1	N = 1
	Walkthrough [interview] (by lecturers)	-	N = 4	N = 2
Quant. data	*Pilot scheme* [survey, pre/post knowledge test (by learners)	-	-	N = 36

Table 46: Mixed-Method Approach to Evaluate the PL-PA
Source: based on Oeste-Reiß et al. (2017)

Data Collection Methods

I raised explorative findings with real stakeholders and based the evaluation on qualitative and quantitative data (Kohlbacher 2006) that comprised the following evaluation methods:

- *Simulations* [requirement-based evaluation and identification of stumbling blocks];
- *Walkthroughs* [interview for stumbling blocks in the process design] by lecturers; and
- *Pilot schemes* [survey, pre/post knowledge test] by learners.

Measures

Based on established scales, measures were adapted from (Petter/Khazanchi/Murphy 2010) and (Briggs et al. 2013).

To analyze the qualitative data I adapted scales from (Petter/Khazanchi/Murphy 2010) (plausible; effective; feasible; predictive; reliable) to build the category system for the content analysis.

To analyze the quantitative data I adapted measures from Briggs et al. 2013 and integrated those in a post survey (5-item scales – satisfaction with process [SP]; satisfaction with outcome [SO]; tool difficulty [TOOLDIF]; process difficulty [PROCDIF]) (Briggs et al. 2013).

Moreover, I used a pre/post knowledge test, each comprising five single-choice questions to investigate findings for knowledge increases among the learners for each treatment.

Context and Background of the Study

All independent lecturers participating in the study teach information systems courses at master levels.

The pilot schemes were conducted in the same master's course on the topic of "Collaboration Procedures" and thus, with the same tasks. The participants were students from German and Swiss universities. In each semester the course is usually attended by 10 to 20 students. Among all pilot schemes a total of N = 36 students [17 males, 19 females], aged 22 to 34 years [mw = 26 years], participated in the PL-PA.

The PL-PA with IT-supported tools (ThinkTank) and paper-based tools (flip chart, cards) was conducted by me as designer and by other lecturers, leading to four subgroups, each representing a treatment (Figure 28).

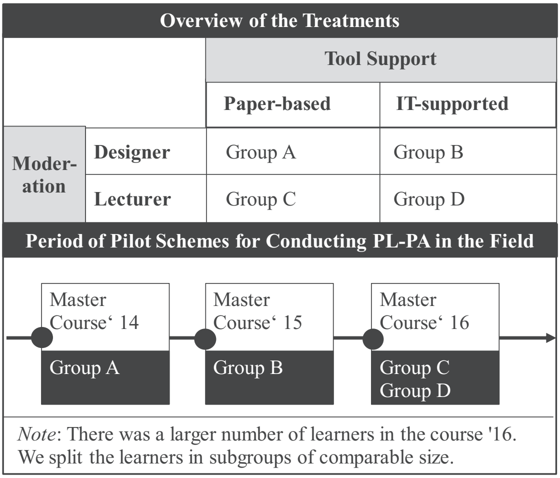


Figure 28: **Treatments in the Pilot Schemes**
Source: based on Oeste-Reiß et al. (2017)

Procedures

Simulation: Before the evaluation in the field, the quality of the PL-PA was assessed by a simulation using a requirement-based evaluation by us as designers to investigate whether the design of PL-PA meets the generalizable requirements.

Walkthrough: During the walkthrough, the design of the PL-PA was presented to lecturers and they were asked to identify inconsistencies. As in the study of PL-PD the design of PL-PA in the form of the FPM, internal agenda and moderation slides was presented to the lecturers. The lecturers examined the FPM and internal agenda on their own. During the presentation of the moderation slides a discussion between the lecturer and the collaboration engineer took place.

Pilot scheme: Participating in the pilot scheme was voluntary and served as preparation for the final exam of the course. The two patterns were bundled, which created a 5-hour learning experience. Learners of a subgroup received a problem situation with four subtasks that required them to describe a blueprint of effective collaboration in the form of a storyline with scenes; each scene had to be described in an abstract and sophisticated way using text and visualizations to demonstrate knowledge concepts. The four subtasks constituted several sequences of scenes. First, learners completed a pre knowledge test, then passed the PSP and CLT, and finally completed a post knowledge test and a survey.

6.2.6.2 Results

Simulation (by designers) – Requirement-based evaluation: A requirement-based evaluation of the PL-PA showed that the design of both patterns cope with the previously derived generalizable requirements (see Table 47). This is in line with (Hevner et al. 2004a; Hevner 2007), and serves as the evaluate part that completes the first design cycle.

GR	Problem-Solving Pattern (PSP)	Critical Thinking Pattern (CTP)
GR 1	Descriptions and moderation plans outline detailed information for lecturers' preparation and guidance instructions for conducting the patterns.	
GR 2	Group procedures describe for each step instructions for enhancing collaboration activities.	
GR 3	Collaboration is systematized in a way that it splits structure in open-ended problem situations with complex tasks and thus, motivates learners cope with this.	
GR 4	In each step learners receive information about whether they should work on their own, or within smaller groups (subgroups, breakout groups), and who the teammates are.	
GR 5	The group product and its subproducts are described and each outlines quality criteria.	
GR 6	Step 1 stimulates individual reflection.	Step 1 stimulates individual reflection.
GR 7	Steps 2, 3 allow discussions and feedback.	Step 2 allows reflection and feedback.
GR 8	Step 3 aims to report a shared solution and thus, creates a shared understanding.	Steps 2, 3 create a revised solution that will be reworked, if there is no consensus.
GR 9	In step 3, exemplary solutions of all subtasks will be discussed within the plenary group.	In step 2, learners will work through all subtasks.
GR 10	Learners work within small breakout groups. Thus, contributions from all teammates are transparent and thus support a feeling of responsibility.	

Table 47: Requirement-based Evaluation of PL-PA
Source: own illustration

Walkthroughs (with lecturers) – Qualitative content analysis: I used a content analysis based on Kohlbacher (2006) and developed a category system that I grounded on measures for pattern evaluation based on Petter et al. (2010) (see Table 48).

Codes	Coding Guideline
Plausible	PL-PA is useful in considering the understanding of the domain.
Effective	PL-PA is described in a language that is understandable; root causes of the problem are identified and addressed by the solutions.
Feasible	PL-PA can be operationalized or implemented as described.
Predictive	PL-PA produces the expected result or produces a result in the intended direction.
Reliable	PL-PA produces similar results regardless of facilitator or technique.

Table 48: Qualitative Content Analysis – Category System and Coding
Source: own illustration based on Petter et al. (2010)

In the following, I summarize the main insights from the three evaluation cycles with regard to the codes from my category system:

- *1st evaluation:* Plausibility, effectivity, and feasibility were examined by a simulation. There were no inconsistencies. To judge whether the PL-PA is predictive or reliable was not possible.

- *2nd evaluation:* Walkthroughs with lecturers resulted in statements such as "*when do the learners work in groups and when do they work alone*". I refined the comprehensiveness of instructions for the lecturer and the subtask wording for learners to improve effectivity. I also refined the grouping structure to improve instructions and rewrote its wording. With regard to the question whether the PL-PA is predictive and reliable, the lecturers felt comfortable and were sure that "*the activities will work and the learners will be motivated*".

- *3rd evaluation*: A lecturer stated his "*[…] feeling of being a coach*". The discussion with each lecturer was, inter alia, about whether the process design of the PL-PA was effective and whether it was reliable. With the help of statements like "*[…] whether the time of that activity is realistic, depends upon the number of subtasks […]*" or "*how does that subsolution serve as relevant input for the next subtask; what are input-output relations between the subtasks?*" I improved the time and the sequence of activities, and thus the granularity of activities. I bundled activities to blocks and adapted validated thinkLets from CE.

Pilot schemes (with learners) – quantitative analysis / descriptive statistics: Pilot schemes with learners helped examine whether PL-PA met the design goals. I derived three hypotheses, each with exploratory research questions that guided my data analysis (see Table 49):

Designer		
H1:	The PL-PA conducted by the designer results in high learner satisfaction.	
	Q1a:	Did the PL-PA with paper-based tools result in high learner satisfaction (T1)?
	Q1b:	Did the PL-PA with IT-supported tools result in high learner satisfaction (T2)?
Lecturers		
H2:	Lecturers are able to conduct the PL-PA as good as the designer of the PL-PA, so that learners are equally satisfied regardless of the moderator.	
	Q2a:	Did conduction of PL-PA by different moderators and with the same paper-based tools result in similar learner satisfaction comparing treatment 1 and 3?
	Q2b:	Did conduction of PL-PA by different moderators and with the same IT-supported tools result in similar learner satisfaction comparing treatment 2 and 4?
Tool Support		
H3:	The conduction of the PL-PA with different tool support leads to comparable scores of perceived satisfaction by the learners.	
	Q3a:	Did conduction of the PL-PA by the designer and with different tool support lead to a difference in learner satisfaction in treatment 1 and 2?
	Q3b:	Did conduction of the PL-PA by lecturers and with different tool support lead to a difference in learner satisfaction in treatment 3 and 4?

Table 49: Hypothesis and Exploratory Research Questions
Source: based on Oeste-Reiß et al. (2017)

To verify that groups started with no bias with regard to group size, gender, and age, I ran a Kruskal-Wallis test. The results showed no significant difference. To investigate findings with regard to knowledge increases I compared the means of pre/post-knowledge tests in all treatments. There was a significant difference in the knowledge test performance in each treatment. Learners performed better in the post knowledge test (mean = 3.6) than in the pre knowledge test (mean = 3.0) (see Table 50).

	N	gender		age	pre-test knowledge	post-test knowledge	p-value (2-tailed)
		male	female				
all groups	36	17	19	26	3	3,6	0.000**
group A	8	5	3	28	3,1	3,6	0.033*
group B	10	7	3	26	2,9	3,7	0.003**
group C	11	5	6	25	2,9	3,5	0.011**
group D	7	0	7	25	2,7	3,5	0.045*
p-value (2-tailed)	1.000^{ns}	0.031^{*}		0.175^{ns}	0.321^{ns}	0.846^{ns}	-

Note: Kruskal-Wallis test; mean difference significant **p< 0.01, *p < 0.05, ns = not significant; knowledge test (5-item scale)

Table 50: Subgroup Structure: Manipulation Check and Knowledge Increases
Source: based on Oeste-Reiß et al. (2017)

To verify whether the means from the satisfaction measures in the post evaluation have a better mean than a test score (neutral average score on 7-point Likert scale) I run a 1-sided t-test (Lehmann/Söllner/Leimeister 2015).

To examine H1, the analysis of Q1a and Q1b showed that all means differed significantly, except in terms of the means from the construct TOOLDF for Q1b. Means were better than the average test score and thus on average and upper levels of the 7-point Likert scale (see Table 51).

To analyze H2 and H3, I run a Mann-Whitney test. The results indicate that learners rated the satisfaction in all treatments on upper levels.

To investigate H2, I analyzed whether the PL-PA can be conducted by different moderators (designer vs. lecturer). Q2a focused on the paper-based tool conduction of the PL-PA by different moderators. I compared the means from treatment 1 and 3. There is no significant difference in the means of SP, SO, and PROCDIF. However, for TOOLDIF (p<0.000) learners in treatment 1 (mean = 6.138) scored significantly higher than learners in treatment 3 (mean = 4.100). Q2b focused on the IT-supported PL-PA conduction by different moderators. Thus, I compared the means from treatment 2 and 4. There is no significant difference in the means of SP, SO, TOOLDIF, and PROCDIF.

To investigate H3, I analyzed whether the PL-PA can be conducted with different tool support (paper-based tools vs. IT-supported). Q3a focused on the PL-PA conduction by a designer with different tool support. A comparison of the means from treatment 1 and 2 showed no significant difference for SP, SO, and PROCDIF. However, for TOOLDIF there was a significant difference by treatment (p<0.000). Learners in the paper-based treatment 1 (mean = 6.138) scored significantly higher than learners in IT-supported treatment 2 (mean = 4.089). Q3b focused on the conduction with different tool support by lecturers. There is no significant difference for SP, TOOLDIF, and PROCDIF when comparing the means from treatment 3 and 4. But learners in the paper-based treatment 3 (mean = 5.640) scored significantly higher than learners in the IT-supported treatment (mean = 6.514).

	Treatment 1 (DP)		**Treatment 2 (DI)**		**Treatment 3 (LP)**		**Treatment 4 (LI)**		Q_{1a}	Q_{1b}	Q_{2a}	Q_{2b}	Q_{3a}	Q_{3b}
	group A		group B		group C		group D		*T1*	*T2*	*T1 vs.T3*	*T2 vs. T4*	*T1 vs. T2*	*T3 vs. T4*
	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	t-value (1-tailed)	t-value (1-tailed)	t-value (2-tailed)	t-value (2-tailed)	t-value (2-tailed)	t-value (2-tailed)
SP	8	5.988 (0.66)	9	5.822 (0.86)	10	5.940 (0.74)	7	6.029 (0.51)	0.000 **	0.000 **	0.929 ns	0.470 ns	0.606 ns	0.669 ns
SO	8	6.025 (0.68)	9	5.533 (1.24)	10	5.640 (0.76)	7	6.514 (0.50)	0.000 **	0.003 **	0.474 ns	0.055 ns	0.606 ns	0.025 *
TOOLDIF	8	6.138 (0.71)	9	4.089 (0.76)	10	4.100 (0.54)	7	3.714 (0.45)	0.000 **	0.368 ns	0.000 **	0.174 ns	0.000 **	0.133 ns
PROCDIF	8	5.163 (0.91)	9	5.756 (0.59)	10	5.680 (0.61)	7	5.486 (0.28)	0.005 **	0.000 **	0.081 ns	0.210 ns	0.093 ns	0.536 ns

Note: Mann-Whitney test; 7-point Likert scale (1= very less; 7 = very high); mean difference significant **p< 0.01, *p < 0.05, ns = not significant

Table 51: Evaluation Results: Means, Differences in Satisfaction
Source: based on Oeste-Reiß et al. (2017)

6.2.7 Discussion

In the following, I discuss the results with respect to the two design goals defined at the outset of this study.

Design Goal 1: Help Lecturers to Enhance PL activities for HLL

Results from the qualitative content analysis provided insights on how to improve the design of the PL-PA. Two lecturers conducted PL-PA during several pilot schemes and achieved comparable results (increases in knowledge test performance; satisfaction measures) with the learners compared to the conduction by the designer.

The results regarding H2 with Q2a and Q2b showed no significant difference in the scores; except for TOOLDIF in Q2a. The difference in the TOOLDIF may indicate that use of paper-based tool support should be described in more detail. The results show that lecturers become empowered to conduct PL-PA and that the PL-PA has the potential to enable knowledge increase among learners.

Design Goal 2: Help Learners to Proceed through PL Activities for HLL

Among all treatments the satisfaction scores were above an average score of 4 and thus, on average and upper levels of the 7-point Likert scale (H1). This indicates that learners are able to follow the PL activities in a positive manner. H3 focused on whether there is a difference in the conduction of PL-PA with paper-based tools and IT-supported tools and thus, which way of tool support is easier for learners to follow. To avoid bias by moderator I compared treatments 1 and 2 (both moderated by the designer) to gain insights for Q3a; and treatments 3 and 4 (both moderated by a lecturer) to gain insights for Q3b.

Q3a showed a significant difference in the measures of TOOLDIF ($p<0.000$). Learners felt more comfortable with paper-based tool support, since they may have perceived the collaboration as being closer. Another explanation could be that they perceived visualizing or editing contributions as a more flexible way, and thus felt more comfortable with it. However, comparing lecturer moderated treatment 3 and 4 results showed no significant difference in TOOLDIF. Thus, the difference in treatment 1 and 2 may be attributed to the facilitation skills of the designer who moderated the PL-PA experience.

A similar conclusion can be drawn with regard to Q3b for SO ($p<0.025$). Learners in IT-supported treatment 4 are more satisfied with the outcome than learners in paper-based treatment 3. Thus, the SO with IT-supported tools seems to be more satisfying. However, when comparing treatment 1 and 2, there is no significant difference in means of SO. An explanation for the significant difference of SO in treatment 3 and 4 may be attributed to the facilitation skills of the lecturer.

6.2.8 Limitations and Future Research

This study is not without limitations, which provide future research opportunities.

- *Modularity of PL-PA:* The evaluation of PL-PA was communicated as a HLL experience. For that reason I built exemplary instances that bundled the PSP and the CTP. Consequently, learners followed a HLL experience in which they passed the PSP and then the CTP. It would be valuable for future research to evaluate each pattern on its own. Such an evaluation will provide deeper insights to the several patterns on its own.

- *Population (N):* In total N = 36 learners participated in the pilot schemes of PL-PA (four subgroups). Thus this might bias the results. To strengthen the results, it would be valuable for future research to evaluate the PL-PA with more groups in a large class. Such an evaluation will provide more robust insights whether learners are able to follow complex HLL tasks by engaging in PL activities.

- *Measuring knowledge increases:* The design goals of this study referred to enhancing lecturers to conduct PL activities for HLL and to providing learners guidance to proceed through these activities. The focus was not on evaluating increases in the knowledge base of learners. In the former study (see chapter 6.1) I already reported results showing that reference processes for PL have the potential to increase the individual knowledge base of a learner. However, those measures focused on LLL. Therefore, future research should investigate knowledge increases among learners in more detail – e.g. group deliverable evaluations by independent lecturers. In particular, follow-up evaluation should assess critical thinking and problem-solving skills in more detail.

- *Transferability with regard to the scope of PL-PA:* In my study different lecturers conducted and evaluated PL-PA in the same master's course either by using paper-based or IT-supported tools. From that point of view PL-PA copes with several aspects of transferability. Nevertheless, the PL-PA was conducted with the same learning task by different lecturers and thus, the results more or less show one case. Future research, therefore, should use PL-PA with different tasks and different lecturers. This will help to strengthen transferability effects of PL-PA.

6.2.9 Contribution, and Conclusion

The contributions of the study are positioned along DSR and more precisely along the components of a design theory (Gregor/Jones 2007):

The *purpose and scope* of the PL-PA is to package sufficient collaboration expertise to conduct PL activities for HLL. To address this set of unsolved problems I provide *principles of form and function* inherent in generalizable requirements to empower lecturers to enhance PL activities and, the PL-PA design with its two patterns. The design provides guidelines for lecturers to enable PL activities for HLL in the classroom. I describe *testable hypothesis* each with exploratory questions to investigate findings towards the design goals of the study. With three design and evaluation cycles I build *expository instantiations* of PL-PA and evaluated it with real stakeholders by using a mixed methods approach. I outline the PL-PA as an approach that helps lecturers to leverage the power of HLL in the disciplines of problem-solving and critical thinking. I base my research on *justificatory knowledge* from PL and CE, and thus, postulate PL-PA's potential for enhancing HLL. The results provide insights for PL literature since they show that principles from CE literature can be applied to the field of learning in a way that process restrictions have the potential to support learners in their HLL experience. With the PL-PA I provide insights in the design of reference processes for PL activities that package sufficient collaboration expertise to empower lecturers to conduct those activities in a predictive way and provide learners guidance to cope with open-ended HLL tasks. Transferability of PL-PA is given when several subgroups (with breakout groups) work simultaneously, since PL activities take place there. Moreover different lecturers are able to conduct PL-PA and achieve comparable results among learners. Those results make a contribution with regard to the transferability of PL-PA and more precisely and in general, to make systematically designed PL activities transferable.

The PL-PA provides prescriptive knowledge and resembles a 'theory of design and action' (Gregor 2006) of the contribution type 'improvement' (Gregor/Hevner 2013). PL-PA with its two design goals focuses on empowering lecturers to enhance PL activities. PL-PA with its both patterns that provide reference processes for PL activities can be classified as a new solution. I respected the generalizable requirements in my design choices. Furthermore, I described the conditions that lecturers have to prepare in order to conduct PL-PA. The description of PL-PA with its two patterns opens modularization opportunities. Thus, in cases that a lecturer prepares the conditions for PL he can decide to combine both patterns or to use one pattern on its own.

6.3 Design Theory for Enhancing Higher-Level Learning in Large University Classes (HLL Design Theory)[11]

6.3.1 The HLL Design Theory in the Context of the Thesis

In this chapter of my thesis I will address RQ 3c

> What are characteristics and effects of peer-learning reference processes? *(Design, implementation, evaluation)*
>
> ➔ RQ 3c: How can one enhance higher-level learning in large classes among students?

Answering RQ 3c serves as a proof of value of systematically designed PL activities. I develop a design theory that comprises the *HLL Reference Process* as a generalizable solution, the *HLL Reference Process Methodology* that illustrates how to develop a Process Support Application (PSA) to run the HLL Reference Process in the field with real stakeholders, and the *HLL Process Support Application* that serves as an exemplary instance.

The former studies that describe reference processes for PL provided valuable insights: e.g. results from the PL-PD (see section 6.1) showed that packaging PL activities in reusable reference processes will lead to knowledge increases and can, in fact, stimulate learning effects; e.g. results from the PL-PA (see section 6.2) showed that packaging PL activities in reusable reference processes has the potential to be transferable. The results focused on different aspects of transferability, e.g. the conduction of the PL-PA by different lecturers. But the studies also outlined aspects for future research, such as expertise evaluations that focus on HLL and the conduction and evaluation of reference processes for PL with a larger population. For example, the former studies focused on expertise and knowledge increases that mainly measured LLL in the evaluations. Thus, in the current study I will address these aspects of future research. For that reason I present the design and evaluation of a design theory for HLL and refer to several components of a design theory in the current chapter. I follow a DSR approach according to Gregor and Hevner (2013).

[11] The insights presented in this chapter are partly based on a study that is ready for submission for the Journal of Management Information Systems (JMIS) (Oeste-Reiß et al. submit to). I thank my collaborators for their valuable feedback on my work. I thank Robert O. Briggs for the many captivating discussions on my work during my time as visiting researcher in spring 2016 at the MIS Department of the San Diego State University in San Diego, CA, USA.

6.3.2 Study Outline and Research Approach

HLL is best served by interactive discourse to develop, defend, and critique positions, and to reason beyond available information to create original intellective work. I build on insights from the PL and CE literatures to develop a design theory for HLL. The design theory, developed in this study, is an approach for designing an IT-based *HLL Reference Process (HLL Process)* for large university classes. The HLL Process serves as a generalizable solution. To build exemplary instances of the HLL Reference Process I develop the *HLL Reference Process Methodology (HLL Methodology)*. To validate the HLL Process, I build an exemplary instance in the form of a *HLL Process Support Application (HLL-PSA)*. A PSA bundles collaboration expertise and the procedures for a collaborative work practice with the supporting collaboration technology in a form that non-experts can use with little or no training. I validate the HLL Process by developing and testing an exemplary instance of the HLL-PSA among students in a large university class in the field. The results of an online quasi experiment show increased HLL among learners of the treatment group that followed the HLL-PSA compared to those who did not follow the HLL-PSA. Learners were able to complete the learning procedure embedded in the HLL-PSA without prior training on the process, the techniques, or technologies. I contribute several elements toward a design theory to enhance HLL in large university classes.

I use the disciplines of DSR to guide my research (Hevner et al. 2004a; Gregor/Jones 2007). Many of the research products for DSR make contributions to design theory (Gregor/Hevner 2013). A design theory is a body of knowledge that practitioners can use to create their own instances of a generalizable solution (Gregor/Jones 2007) (see section 3.2.2). In the following I explain the research products of this study:

- The section on the problem statement (see section 6.3.3) outlines the *purpose and scope* of my proposed solution.
- My definition of the phenomenon of interest, expertise, (see section 6.3.4.1) contributes to the c*onstructs* category.
- The theory section (see sections 6.3.4.2, 6.3.4.3) provides *justificatory knowledge* that I use to defend key design choices.

- My generalizable requirements for HLL Processes (see section 6.3.5) and the design of the HLL Process (see section 6.3.6) contribute to *principles of form and function*.

- My HLL Methodology (see section 6.3.7) contributes *principles of implementation*.

- My HLL-PSA represents a prototype (see section 6.3.8) and serves as an *expository instantiation* of my generalizable solution.

Therefore the structure of this study is organized as follows. In kernel theories section 6.3.4, I summarize theoretical logic from the learning and PL literatures as well as collaboration literature that I used to inform the design choices for a generalizable HLL Process solution. Section 6.3.7 draws on CE literature to develop an approach to designing and implementing HLL-PSA as an exemplary instance of HLL Processes. I call it the HLL Methodology. In section 6.3.8 I describe the HLL-PSA. This serves as an exemplary instance and is inherent in a prototypical description of the implementation of HLL-PSA. In section 6.3.9 I report the evaluation and refer to a requirement-based evaluation and an online quasi experiment in a large information systems university class. This helps to validate the utility and generalizability of the HLL-PSA. In section 6.3.10 I report the results, followed by a discussion in section 6.3.11. I finish in section 6.3.12 with the implications of this study for research and practice, the limitations, and future research directions.

6.3.3 Problem Statement and Design Goals

With the increasing availability of information, the performance of knowledge workers now depends on the degree to which they have mastered critical thinking, problem-solving, communication, and collaborating with others to create new value with information (David/Foray 2003; García-Aracil/Van der Velden 2008; Johnson et al. 2015). Consequently, universities face a rising need to create higher-level learning (HLL) experiences for students (Chiru et al. 2012). HLL refers to the upper levels of Bloom's revised taxonomy of educational objectives (Krathwohl 2002). At the higher levels of the taxonomy, learners achieve abilities to evaluate information and arguments, to construct, critique, and defend positions, and to reason beyond available information to produce original intellective works.

HLL, however, cannot be well served by large-classroom experiences. A large class format is one in which class size ranges from about 40 to several hundred students. Large classes provide few opportunities to reason, develop, and challenge positions (Vygotsky 1978; Webb 2010). Financial pressure, however, drives universities to larger classes. In the USA for example, funding per full-time equivalent (FTE) student in public institutions declined from $10,110 in the years 2000–01 to $ 7,540 in the years 2014–15. In parallel, there was an increase of 16% in enrollment numbers from fall 2003 to fall 2013, giving rise to larger classes (Ma et al. 2015). Larger class sizes have a negative relationship with learners' performance (Kokkelenberg/Dillon/Christy 2008). The challenge to increase HLL is large by the fact that some learners arrive in a class with more understanding of the content than others. It can be difficult to design HLL activities that challenge the top students without losing the bottom students.

This situation prompts my research question:

How can one enhance higher-level learning in large classes among students?

PL literature offers useful approaches that have been shown to foster learning in groups (Topping 2005). However, group effectiveness tends to decline as group size increases beyond five or six participants (Ingham et al. 1974), so many PL approaches are not suited to large classes. One could divide a large class into smaller groups for PL activities. However, many current PL approaches – e.g., collaborative learning scripts (Dillenbourg 2002; Kollar/Fischer/Hesse 2006) – foster the acquisition of lower-level domain knowledge (Kollar/Fischer/Hesse 2006). Few support HLL, and those that do support HLL tend not to be practical for large classes.

The challenge of PL in large classes may be exacerbated because some authors posit that instructors should not prescribe collaborative procedures for learners; group processes should be emergent and ad hoc so as not to stifle student creativity and learning (Bodner 1986; Poplin 1988; Dillenbourg 2002; Jones/Brader-Araje 2002). However, field experiences suggests that most individuals do not have an intuitive grasp of how to collaborate effectively, so, left to themselves, most groups tend to be inefficient and ineffective work practices evolve (Briggs et al. 2013). Furthermore, most students would not be skilled at designing effective learning experiences for HLL.

CE provides an approach addressing this question. CE is an approach to designing collaborative work practices for high-value tasks and transferring them to practitioners to execute for themselves without ongoing support from an expert facilitator (Briggs/de

Vreede/Nunamaker 2003). Research shows that process restrictions (tools and procedures designed to restrict groups to productive actions that they want to take, and restrict them from counter-productive actions they do not want to take) can yield discontinuous improvements in group outcomes. Teams using well-designed collaborative work practices can increase the number of communication cues the members exchange; increase the number, quality, and creativity of ideas they produce; reduce cognitive load, cut the time and effort required to complete a task, while improving the quality of its work products, and increasing satisfaction with processes and outcomes (Dennis/Nunamaker Jr/Vogel 1990; Fjermestad/Hiltz 1998; Jerry Fjermestad 2000; Briggs et al. 2013). I draw on the principles of CE to propose a generalizable solution for implementing technology-supported collaborative HLL experiences.

In this study I therefore use CE to develop and validate a design theory for HLL that professors and lecturers can use to create HLL experiences for large university classes. The objective is to develop a design theory for HLL that comprises the HLL Process, the HLL Methodology, and the HLL-PSA that meets the following design goals:

- *Design Goal 1: Enhance HLL for large class contexts;*
- *Design Goal 2: Package sufficient collaboration expertise in the process design so that non-experts (learners) can execute a well-designed work practice without training in tools or techniques.*

6.3.4 Kernel Theories for Achieving Higher-Level Learning by Collaboration

This section draws on scientific literature to propose a generalizable solution for deriving collaborative HLL activities for large classes. I begin by defining the nature of the learning. I continue with PL literature since the HLL Process as generalizable solution aims to enhance HLL. Thus, existing literature on PL provides useful insights to understand the anatomy and mechanisms of learning in order to design activities for enhancing HLL learning effects. While most people do not have an intuitive grasp of inventing ad hoc collaborative processes, I report collaboration literature that helps to engineer reusable collaborative processes. This builds the methodological foundation to develop the HLL Process and HLL Methodology.

6.3.4.1 Phenomenon of Interest in the Study

In a DSR study, the phenomenon-of-interest is the measurable outcome one seeks to improve with one's proposed solution. The phenomenon of interest for this study is expertise. Expertise refers to the levels-of-complexity that characterize an individual's knowledge in some domain. Knowledge, is defined as "the fact or condition of being aware of something: the range of one's information or understanding" (Dictionary 2016). To clarify the meanings of levels-of-complexity or levels-of-mastery in this context, I first summarize some theoretical principles of cognitive science.

Humans have at least two classes of memory: long-term memory, and working memory. *Long term memory* stores the knowledge an individual accumulates over a lifetime, while *working memory* is the temporary workspace of human attention (Baddeley 1997). Long term memory organizes knowledge into bundles of related concepts called schemata (Brewer/Nakamura 1984) or frames (Neisser 1967). A frame for the concept, picnic, for example, might bundle the concepts of food, eating, basket, blanket, outdoors, sunshine, and ants. Frames are interconnected into a network of frames by the concepts the frames share (Collins/Loftus 1975). A picnic frame, for example, might be connected to a beach frame via the shared concepts outdoors and sunshine. External stimuli automatically activate one or more frames, which mean moving them temporarily into working memory. Once a frame is in working memory, its presence may activate other closely related frames (Collins/Loftus 1975). However, working memory is limited; it has only a handful of slots, so at a given moment, it can contain only a handful of frames, with each frame occupying one slot (Miller 1956; Barrouillet/Camos 2007). Thus, at a given moment, an individual can think about only a small subset of the knowledge stored in long term memory. However, when frames appear together in working memory frequently enough, then chunking occurs (Belleza/Young 1989; Gobet et al. 2001), which means that multiple smaller frames combine to form a single, more-complex frame that takes up only one working memory slot. When that happens, the individual can work with more knowledge without having more working memory.

The *level-of-complexity* of an individual's refers to the degree to which the domain knowledge they hold is chunked. As frames chunk, the complexity of an individual's understanding of the relationships among concepts in a knowledge domain increases. A person with complex knowledge might, for example, be able to make judgments in terms of internal evidence and external criteria, and to synthesize information into new patterns and alternative solutions. A person whose knowledge remains in smaller chunks might only be able to recall facts, or recognize and explain concepts.

Because of these cognitive mechanisms, individuals cannot move directly from ignorance to expertise; they must proceed in stages. *Mastery* of each simpler level (creating small, less-complex chunks) is prerequisite to mastery of the next more complex level (Krathwohl 2002). One must first understand basic domain knowledge before one can chunk those frames into understandings of more-difficult domain knowledge. Full mastery is attained when an individual has built multiple layers of understanding, one upon another, until no new domain knowledge remains to be learned and chunked. One whose chunks are more complex is said to have a higher level of knowledge than one who's chunks are smaller.

Quantity-of-knowledge, by contrast, refers to the number of concepts and facts one can recall. It would be possible for a non-expert to have a greater quantity of knowledge than an expert in the same domain. A savant who could recite the statistics for every professional baseball game since 1890 might recall more facts than an expert who could nonetheless devise strategies and tactics to defeat a physically superior adversary. Thus, expertise refers to the level-of-complexity of an individual's frames pertaining to a given knowledge domain.

6.3.4.2 Basics in Peer Learning

Much of the PL literature builds on constructivist learning theory, which posits that learners learn via interactions with their environments (Moll 2013). Moore classifies three types of learning interactions: learner-lecturer interactions, learner-content interactions, and learner-learner interaction (Moore 1989; Schrum/Berge 1997). *Learner-lecturer interactions* have the potential to stimulate cognitive learning mechanisms (Wang/Haertel/Walberg 1990; Liu et al. 2003) as learners request clarification of unclear issues and test their knowledge (Leasure/Davis/Thievon 2000; Thurmond/Wambach 2004). Active engagement between the learner and the lecturer would trigger the juxtaposition of related frames in working memory. *Learner-content interactions* (e.g., in the form of reading text, listening to audio, or watching video can also trigger frame development and chunking (Alavi/Marakas/Yoo 2002) but may offer fewer opportunities for feedback on the quality of new understandings. *Learner-learner interactions*, e.g. learners explaining concepts to one another, debating positions would also fuel the aggregation of simpler frames into more complex frames (Alavi/Marakas/Yoo 2002).

Since learners usually have different levels of domain knowledge, the less-knowledgeable learners benefit from input by the top-learners, and top-learners improve the quality of their own frames by, for instance, having to make their tacit understandings explicit in order to articulate them for the less-advanced learners (Snell 1999; Smith et al. 2009). This social involvement also may increase learner motivation (Liu et al. 2003; Sims 2003; Eisenkopf 2010), and so stimulate greater effort toward learning (Fredericksen et al. 2000; Moore/Kearsley 2011). Thus, chunking, and therefore increases of expertise can occur through social experiences among learners (Damon 1984; Harris 1998; Dillenbourg 1999; Hua Liu/Matthews 2005a; Topping 2005). As an additional benefit of PL, students also improve skills such as communication, cooperation, critical thinking, and problem-solving (Damon 1984; Gagné 1984; Topping 2005; Arbaugh 2010; Wegener/Leimeister 2012; Jones 2014).

Thus, if learner-learner and learner-content interactions could be implemented in a large class setting, it might be possible to increase HLL. As noted, however, students tend to lack both collaboration skills and learning-design skills. A CE approach, however, might mitigate those deficits.

6.3.4.3 Basics in Collaboration Engineering

In this study, I draw on the structured methodologies of CE (Kolfschoten/De Vreede 2009b; Randrup/Briggs 2015) as a foundation for the HLL Process and HLL Methodology. The heart of the CE design methodologies is the Six-Layer Model of Collaboration (Briggs et al. 2014b) (see section 2.2.3), which considers collaboration processes at six different levels of abstraction.

Separating the cognitive mechanisms of learning and the functional mechanisms of collaboration gives rise to CE. This is an approach for designing high-value collaborative tasks and transferring them to practitioners to execute for themselves without ongoing support from an expert facilitator (Briggs/de Vreede/Nunamaker 2003). A high-value collaborative task is one which creates substantial value. Such value refers to the productivity of the group developing a collaborative deliverable. Productivity is embodied in aspects of time or group deliverable quality. Thus, examples of substantial value are groups that achieve the same deliverable quality in less time; groups that achieve a better deliverable quality in the same time or groups that achieve a deliverable that avoids making mistakes (de Vreede/Briggs 2005). In the context of HLL, using CE has the potential to help groups of learners to achieve a HLL performance or to quickly achieve higher-levels of domain knowledge compared to individual learning.

The six layer-model of collaboration[12] provides guidance to systematically design collaborative activities as a reusable work-practice. It consists of six layers, each providing guidance for designing collaboration (Briggs et al. 2014a). The layers are group goal, group product, group activities, group procedures, collaboration tools, and collaboration behaviors (Briggs et al. 2006; Briggs et al. 2014a).

The HLL Process addresses each of these six layers while the HLL Methodology provides additional insights to build the HLL-PSA that practitioners can use without training in tools and techniques.

6.3.5 Generalizable Requirements for Enhancing Higher-Level Learning in Large University Classes

Following I outline generalizable requirements (GR) for enhancing HLL in large classes. The GR are informed by justificatory knowledge from learning, PL and CE literatures (see section 6.3.4), and by the as-yet unsolved problem (see section 6.3.3). Enhancing HLL in large classes presents cognitive, operational and collaborative challenges.

Many individuals do not have an intuitive grasp of how to conduct effective, efficient collaboration, and the difficulty of group work tends to rise as group size increases (Ingham et al. 1974). Therefore:

> *GR 0. Influencing Group Behavior by Group Size:* An HLL solution for large classes should support subdividing the class into parallel breakout groups of 6 or fewer students to minimize the emergence of dysfunctional group behaviors that could interfere with learning.

HLL occurs when individuals manipulate multiple less-complex frames to achieve goals that require higher-level knowledge, for instance, evaluate the quality of information, reason from first principles and evidence to a new position, judge the merits of proposed solutions, or a new intellective work product (Krathwohl 2002). A conventional large classroom is not conducive to engaging all learners in such tasks, yet they are essential for HLL. Therefore:

[12] For detailed description see section 2.2.3.

> *GR1. Task Complexity:* HLL solutions should challenge learners with tasks that require them to synthesize less-complex frames into more-complex frames.

Learners usually arrive in a class with differing levels of domain knowledge. Collaboration research shows that, under some conditions, groups comprising people with a different levels and amounts of knowledge can achieve a greater gains in productivity than homogeneous groups (Ries et al. 2013). All learners benefit from formulating, then advancing positions, critiquing the positions of others, and defending their own positions. The less-knowledgeable learners benefit from the knowledge of the top-learners; the top-learners benefit from making tacit knowledge explicit (Snell 1999; Smith et al. 2009). This social involvement also may increase learner motivation (Liu et al. 2003; Sims 2003; Eisenkopf 2010).

> *GR2. Generating Shared Knowledge Base:* An HLL solution should foster the give-and-take that leads to the creation of shared understandings of, e.g. shared information and knowledge; of various positions and the logic by which they were derived, and of the goals and interests of others. It should give opportunities for learners to compare, and then challenge or reinforce one another's understandings.

Because some learners will be more knowledgeable than others, learning experiences targeting the top-learners may be too difficult for others, while experiences targeting the novice learners may give top-learners no opportunity to learn. This difficulty can be addressed in a variety of ways, e.g. by designing learning experiences with different roles for top students and novices. Therefore,

> *GR3. Ensuring Reciprocity:* The learning experience should not be too difficult for less-knowledgeable learners to understand, yet should not be so easy that it wastes the time of advanced top-learners.

Newly chunked frames often incorporate incomplete and incorrect understandings. Learners can verify the validity of a new frame by using it to attempt a task. Working memory, however, fades within seconds unless it is refreshed, and new frames in long-term memory fade if they are not reinforced. It is useful, therefore, for learners to get an assessment of the quality of their attempts to use new higher-level knowledge as quickly as possible. Therefore:

> *GR4. Providing Rapid Feedback:* Learners should receive feedback on their assertions of knowledge quickly.

It is time consuming and sometimes expensive to develop and refine an effective, reusable collaborative work practice. To optimize the utility of the solution for HLL, therefore,

> *GR5. Respecting Flexibility:* The solution should not be tied to a specific lesson. It should be useful for creating teaching/learning experiences across a wide variety of knowledge domains.

Universities and organizations do not typically have funds to support collaboration experts to create new learning experiences. Therefore:

> *GR6. Leveraging Available Personnel:* It must be possible for the people already assigned to a large course to use the solution to create new collaborative HLL solutions without the assistance of experts in collaboration or collaboration technology.

Universities and other organizations have limited financial resources. Bespoke or customized tools for PL would be expensive. Therefore,

> *GR7. Leveraging Available Resources:* It should be possible to create an instance of a collaborative expertise-building solution for large classes using capabilities that are already commonly available at universities and organizations.

Instructors in a conventional large-class setting already experience high demands on their attention. They may therefore decline to adopt a new approach with a steep learning curve. Therefore,

> *GR8. Ensuring Transferability:* An instructor should be able to use the solution in their own context with little or no training.

Learning new, complex, high-level knowledge places a high cognitive load on students. Collaboration adds to that cognitive load, e.g. for shaping the process, communicating, reasoning about the contributions of others, maintaining goal congruence, and minimizing distractions. Therefore, *GR9. Minimizing Cognitive Load:* The solution should minimize cognitive load for actions not directly related to learning, to maximize cognitive resources available for learning.

Most people do not have an intuitive grasp on how to design effective, efficient collaborative work practices. Most students lack the expertise to design effective learning experiences. Therefore:

GR10. Prescribed Procedures: An HLL solution should prescribe procedures for an effective learning experience that students can follow without training.

Under most conditions, the difficulty of group work tends to rise and the effectiveness of groups tends to decrease as group size increases beyond five or six people (Ingham et al. 1974). To conserve cognitive resources for HLL tasks, therefore:

GR11. Influencing Cognitive Resources by Breakout Groups: An HLL solution should support the dividing of a large class into small breakout groups of no more than 5-6 students (Ingham et al. 1974).

Collaboration research also shows that, under some conditions, groups comprising people with different levels and amounts of knowledge can achieve a greater gains in productivity than homogeneous groups (Ries et al. 2013). Therefore:

GR12. Heterogeneous Learning Groups: The solution should assure that each breakout group has a mix of the most- and least-advanced learners.

6.3.6 The HLL Reference Process (HLL Process)

The aim of the HLL Process is to initiate small-group collaboration to allow HLL in large-classes. Consequently, the HLL Process uses IT-supported distributed teams.

To clarify how the learners get in touch with each other as they progress through the several steps of the HLL Process, the learners are divided into smaller groups: The *plenary group* describes the total number of participants and therefore consists of all learners who participate in the large class setting. Learners in the plenary group are divided into smaller groups called a *subgroup*. And in turn, learners of a subgroup are divided into yet smaller groups called a *breakout group*.

The HLL Process comprises in total five steps of activities:

- *Step 1 – Registration*: Learners register to participate in a HLL learning experience and thus, in the HLL Process.
- *Step 2 – Knowledge Test*: Learners complete a knowledge test that builds the basis for building small groups of knowledge heterogeneous learners.
- *Step 3 – Brainstorming*: The collaboration starts in step 3 when the learners become assigned to subgroups in which they receive several learning tasks on which they have to brainstorm solution ideas.
- *Step 4 – Converging*: The collaboration continues and learners become assigned to breakout groups, each with one learning task. Learners examine the solution ideas from the step before, organize the solution ideas, eliminate redundant solution ideas and add missing knowledge concepts.
- *Step 5 – Report*: The collaboration in the breakout groups continues. The learners report their solution by using meaningful text and visualizations in order to represent a sophisticated understanding of the knowledge concepts.

The description of the several steps of the HLL Process is structured along the Six-Layer Model of collaboration (see section 6.3.4.3). It starts with the definition of the collaboration goal and illustrates for each step the specification of a group deliverable as sub-product, group activities, group procedures, tools and, group behavior.

6.3.6.1 Collaboration Goal

The HLL Process counts for a specific group goal. A goal describes a desired state or outcome and motivates individuals for action since goal attainment leads to satisfaction (Briggs/Reinig/de Vreede 2008). The likelihood of attaining a goal motivates individuals to work towards the goal (Briggs/Reinig/de Vreede 2008). It is essential that individuals perceive working towards a collaboration goal as instrumental for achieving their individual goals (Briggs et al. 2014a). Therefore, the goal of the HLL Process is:

While improving their expertise (achieving higher-levels and greater amounts of domain knowledge) and higher-level thinking skills (abilities for critical thinking, problem-solving, communication, and cooperation) through collaboration with each other, learners make themselves more attractive for future employers.

Whether a goal is instrumental in attaining individual goals mainly depends on the kind and the structure of the collaborative high-complexity task. This task points out the expectations for the group deliverable (group product) that the learners have to create. A high individual goal utility can be emanated, since learners usually want to increase their expertise and higher-level thinking skills in order to make themselves more attractive for employers.

6.3.6.2 Step 1: Registration – Individual (Asynchronous)

Since the number of subgroups and breakout groups for the further steps mainly depends on the number of participants, the goal of the first step is to produce a list of participants. Thus, this step only focuses on the registration and the learners receive no information about the content of the case or its subtasks. Table 52 serves as the design pattern, outlining each of the six key aspects of this step.

Product	
Input	None.
Output	List of learners.
Indicators of quality	Non-redundant identification of each learner (e.g., name, mail).
Activity	
General description	To participate in the HLL Process, learners pass a registration with one selection option. Learners who don't want to participate do not register.
Grouping	Individual.
Time	No time restrictions. Step must be completed to a defined date.
Procedures	
Pattern of Collab.	Generate.
thinkLet	None.
Instructions	Learners receive information how to register and how long the registration is open.
Tools	
Tools	Learning Management System (LMS): IT-supported registration.
Strengths	Time-efficient, automated list of participants.
Weaknesses	Relies on a stable internet connection.
Configuration	To set up a registration, the instructor uses LMS functionalities with one selection option that provides no reference to subtasks.
Data structures	Non-redundant list of participants (e.g., name, email).
Behavior	
Process restrictions	To reduce cognitive load learner behavior is restricted as follows:
Technology restrictions	Learners only get access to functionalities for registration.
Guidance restrictions	Learners only receive registration relevant information for the current step. After a successful registration, learners receive feedback that they are registered as well as an outlook for the next step.
Training restrictions	None.
Transitions (Conditions to pass this step)	
Changes of data	None.
Changes of orientation	Asynchronous. Learners receive feedback, that the registration was successful.
Changes of capabilities	Learners receive a hint of provided functionalities and what they are allowed to do.

Table 52: **Step 1: Registration – Individual (Asynchronous)**
Source: own illustration

6.3.6.3 Step 2: Knowledge Test – Individual (Asynchronous)

Only learners who pass all the requirements of step 1 receive access to step 2. Since it is important to build groups of learners having heterogeneous domain knowledge, the knowledge test aims to identify learners' expertise on lower levels of domain knowledge. Performance on the knowledge test enables identification of bottom and top learners and their subsequent assignment to expertise-heterogeneous groups. Table 53 serves as the design pattern, outlining each of the six key aspects of this step.

Product	
Input	List of learners. At least one true-false question (true/false) comprising domain knowledge of each subtask.
Output	List of learners, with a knowledge test score for each learner.
Indicators of quality	The knowledge test score (e.g. in the case of four true-false questions: '4').
Activity	
General description	Learner opens the knowledge test in the LMS and answers all provided true-false questions.
Grouping:	Individual.
Time	No time restrictions. Step must be completed to a defined date.
Procedures	
Pattern of Collaboration	Generate, Organize.
thinkLet	None.
Instructions	Learners receive information for: a) the period of time in which they have the chance to participate to the knowledge test; b) the approximate duration for completing the knowledge test; c) how the mechanism for completing the knowledge test works.
Tools	
Tools	Learning Management System (LMS): IT-supported (online) quiz.
Strengths	Time-efficient, identification of knowledge test performance (=scores) for each learner.
Weaknesses	Relies on a stable internet connection.
Configuration	To capture the current domain knowledge, the instructor uses LMS quiz functionalities, and integrates at least one true-false choice question for each subtask.
Data structures	Non-redundant list with participants and their performance scores on the knowledge test.
Behavior	
Process restrictions	To reduce cognitive load, learner behavior is restricted as follows:
Technology restrictions	The functionalities for the knowledge test are automatically unlocked for learners.
Guidance restrictions	Learners only receive knowledge test-relevant information. After the knowledge test, they receive feedback whether they passed the step and an overview of the next step.
Training restrictions	Participants receive a walkthrough video outlining an overview of the next steps and the use of the provided tool functionalities.
Transitions (Conditions to pass this step)	
Changes of data	None.
Changes of orientation	Asynchronous. Learners receive feedback: a) that they are in step 2; b) that they passed the knowledge test in step 2.
Changes of capabilities	Learners receive a hint of provided functionalities and what they are allowed to do.

Table 53: Step 2: Knowledge Test – Individual (Asynchronous)
Source: own illustration

6.3.6.4 Step 3: Brainstorming - Subgroups (Synchronous)

The collaborative task solving starts in step 3. During this step, all HLL activities take place at the same time, but at different places. The learners work in distributed teams. In order to minimize the efforts of an external moderator, all instructions are distributed automatically using IT-tools. If the learners have to switch to the next step, the IT-tools unlock the relevant instructions. The duration of this step has a time limit.

Depending on their knowledge test performance, the learners are automatically assigned to heterogeneous subgroups. Each subgroup receives at least two and maximum four learning tasks. Every learner brainstorms solution ideas for all subtasks, without knowing on which subtask he will work on in more detail in the next step. Thus, learners contribute knowledge concepts to categories representing all of the subtasks. This gives the top learners a chance to bring relevant concepts into working memory, and to provide their input for each of the subtasks. This also opens the opportunity for chunking. The bottom learners will read ideas contributed by the top learners. This builds some initial frames in the bottom learners, triggering an activation of relevant concepts they could contribute but had not considered until they saw the contributions of the top learners. This in turn increases the concept set for bottom learners, helping them build low-level understanding of the knowledge domain. Consequently, this constitutes a step towards HLL. Table 54 serves as the design pattern, outlining each of the six key aspects of this step.

Product	
Input	Depending on the case and its number of subtasks, create a breakout group of min. 2 and max. 6 participants for each subtask. Cluster all breakout groups into one subgroup (one case is assigned to one subgroup; a case comprises a number of subtasks = number of breakout groups). If there are more participants, allocate the case several times and create more groups. Per subgroup, create a collaboration space in the form of a shared writing page with a list of topics to be addressed by the participants. Each topic represents one subtask.
Output	Per subgroup, a document with a set of comments and ideas for solving each subtask.
Indicators of quality	Aspects for the solution per subtask in the form of meaningful knowledge concepts represented by keywords.

Activity	
General description	Learners receive general instructions and open shared writing page with the description of the case and its subtasks. Each learner brainstorms ideas for the solution for each subtask without interacting directly with other learners. Learners are aware of each other because everybody can read all contributions.
Grouping	≥ Subgroup (each comprising min. 2 breakout groups [each min. 2 participants]).
Time	Time limit for collaboration.
Procedures	
Pattern of Collaboration	Generate
thinkLet	LeafHopper: Setup: Create a shared writing page with a list of topics (=one topic resembles one subtask). Steps: a) Explain and verify understanding of the topics; b) Explain expectations to contributions of the learners; c) Prompt learners to work on topics in which they have the most expertise. Also request them to look at each topic and read comments of others as well as contribute to them; d) Indicate to the learners that they will not have enough time to work on every topic.
Instructions	Learners receive information about: a) The duration of time for the brainstorming; b) How the mechanism for brainstorming works; c) In what format they have to write down their ideas; d) When and how they have to move to the next step.
Tools	
Tools	LMS allowing separated groups; collaboration space providing shared writing pages.
Strengths	Time-efficient, shared writing page for same-time collaboration
Weaknesses	Relies on a stable internet connection, and on switching between LMS and collaboration space with shared writing page.
Configuration	Set up subgroups in LMS and provide each subgroup access to the shared writing space.
Data structures	One shared writing page with solution aspects for all four subtasks from each subgroup.
Behavior	
Process restrictions	To reduce cognitive load, learner behavior is restricted as follows:
Technology restrictions	Learners get automatic access to the collaboration space with the shared writing page. On the shared writing page, learners have restricted rights (e.g., only editing); when the time is over, the rights change such that learners only can read the contributions.
Guidance restrictions	Learners receive information for the current step to complete the brainstorming activity. They receive instructions to get access to the subtask by opening the shared writing page, and then to read further task-relevant instructions on the shared writing page and when the time is over move back to the LMS to move to step 4.
Training restrictions	None. Walk-Though video was provided in the step 2.

Transitions (Conditions to pass this step)	
Changes of data	Each subgroup receives a shared writing page with the description of the case and subtasks.
Changes of orientation	Synchronous. Learners are assigned to separate expertise-heterogeneous subgroups and receive certain information: a) That the following three steps take place synchronous; b) That they are in a subgroup in which they will indirectly collaborate with other learners; c) In which step they are in and how to move forward.
Changes of capabilities	Learners receive a hint that they are allowed to open and edit the shared writing page, and that after a certain time, they will be able to only read the document.

Table 54: Step 3: Brainstorming – Subgroups (Synchronous)
Source: own illustration

6.3.6.5 Step 4: Converging – Breakout Groups (Synchronous)

The task solving continues in step 4. While in step 3 the learners worked in subgroups, in step 4 the system automatically splits them up into breakout groups. Now, the learners also get assigned to one subtask and receive the solution input for their subtask from the step before. Step 4 consists of the following collaborative activities:

- Learners discuss the degree to which contributed concepts and relationships are relevant to their subtask;
- They summarize redundant knowledge concepts;
- They check the completeness of the concept set and add missing concepts and relationships.

This requires learners to consider the concepts and relationships in more detail, meaning more juxtaposition of concepts and relationships in working memory, which leads to more chunking, thereby increasing the complexity of their frames, which constitutes HLL. Table 55 serves as the design pattern, outlining each of the six key aspects of this step.

Product	
Input	One collaboration space for each breakout group, with a shared writing page including the solution aspects for the subtask from brainstorming activity (step 3), and three categories (1 - correct aspects; 2 - false aspects; 3 - summarized aspects) for organizing the solution aspects.
Output	One shared writing page for each breakout group with aspects for solving the subtask.
Indicators of quality	Organized, corrected and complemented summarized solution in the form of text.
Activity	
General description	Learners open collaboration space with their assigned writing page; read instructions for continuing with the solution of one subtask; read the case and the one subtask, with its brainstormed solution aspects. Then, learners organize solution inputs, clarify ambiguous aspects, summarize, and complement correct aspects by discussing with each other.
Grouping	Breakout groups (each min. 2 and max. 6 learners).
Time	Time limit for collaboration.
Procedures	
Pattern of Collaboration	Organize
thinkLet	PopcornSort Setup: Divide each subgroup into several breakout groups (per subtask one breakout group). Assign every breakout group to a shared writing page with one subtask comprising the unordered list of solution aspects from the before brainstorming activity. Provide on the writing page categories for correct aspects, false aspects, and summarized aspects. Steps: a) Explain and verify understanding of instructions and categories b) Copy the aspects of the previous brainstorming activity to the categories. c) Summarize the correct aspects to a meaningful explanation.
Instructions	Learners receive information about: a) the duration of time for converging ideas; b) how the mechanism for converging works; and c) in what format they have to organize and summarize the ideas.
Tools	
Tools	LMS allowing separated groups; collaboration space providing a shared writing page.
Strengths	Time-efficient, shared writing page for same-time collaboration.
Weaknesses	Relies on a stable internet connection, switching between LMS and collaboration space with shared writing page.
Configuration	Set up several breakout groups for the subtask in the LMS and provide each breakout group access to a collaboration space with a shared writing space.
Data structures	One shared writing page for each breakout group, comprising of one subtask and its brainstorming ideas.

Behavior	
Process restrictions	To reduce cognitive load, learner behavior is restricted as follows:
Technology restrictions	After step 3 activities, learners get automatic access to the collaboration space with the shared writing page. On the writing page, learners have restricted rights (e.g. editing); when the time is over, the rights change and learners only can read the contributions.
Guidance restrictions	Learners receive converging relevant information for the current step. They receive instructions to get access to the subtask by opening the writing page. When the time is over learners receive information to move back to the LMS in order to move to step 5.
Training restrictions	None. Walkthough video was provided in step 2.
Transitions (Conditions to pass this step)	
Changes of data	Each breakout group receives a shared writing page with one of the subtasks comprising the related brainstorming ideas from the step before. (Content from the writing page from step 3 is divided into several writing pages, each with one subtask).
Changes of orientation	Synchronous. Learners from a subgroup are assigned into expertise-heterogeneous breakout groups. Learners receive information: a) that they are in a breakout group in which they will collaborate directly with other learners on the solution of one subtask; b) about which step they are in and how to move forward.
Changes of capabilities	Learners receive a hint that they are allowed to open and edit the shared writing page, and that after a certain time, they can only read the document.

Table 55: **Step 4: Converging – Breakout Groups (Synchronous)**
Source: own illustration

6.3.6.6 Step 5: Reporting – Breakout Groups (Synchronous)

In this step, the learners remain in their breakout groups and report their solution by using text and visualizations in order to represent a sophisticated understanding of knowledge concepts. Learners discuss how the concepts and relationships can be reported. They are told they must:

- Visualize the concepts and relationships; and

- Use short, meaningful phrases.

The instructions suggest that breakout groups plan action items for team members to complete the deliverable. This procedure was not mandatory for building the deliverable. The deeper discussion of concepts and relationships, and the application of the understanding to designing and presenting a solution triggers more juxtapositions and more chunking of domain knowledge and thus, a HLL. Table 56 serves as the design pattern, outlining each of the six key aspects of this step.

Product	
Input	One collaboration space for each breakout group, with a shared writing page allowing text and graphic edits for one subtask and an empty slide show for reporting the solution.
Output	For each breakout group, an abstract solution for one subtask representing a new integrated and meaningful domain knowledge concept.
Indicators of quality	Solution comprises all relevant domain-knowledge in the form of text and meaningful visualizations among knowledge concepts.
Activity	
General description	Learners open collaboration space with their assigned writing page for the slide show; read the instructions for continuing with the solution of one subtask. Then, they report their previously created solution on 5 slides while discussing with each other.
Grouping	Breakout groups (each min. 2 and max. 6 learners).
Time	Time limit for collaboration.
Procedures	
Pattern of Collaboration	Clarify.
thinkLet	BucketBriefing. Setup: Assign every breakout group to a shared writing page (e.g. slide show) for reporting the solution. Provide an empty writing page (e.g. slide show). Steps: a) Explain that learners have to work in the shared writing page (e.g. slide show). b) Explain to learners the quality criteria for reporting the solution.
Instructions	Learners receive information about: a) the duration of time for reporting the solution; b) the quality criteria for reporting the solution; c) how the reporting activities should take place.
Tools	
Tools	LMS allowing separated groups; collaboration space with a shared writing page (e.g. slide show)
Strengths	Time-efficient, collaboration space for same-time collaboration.
Weaknesses	Relies on a stable internet connection, switching between LMS and collaboration space with shared writing page.
Configuration	Provide access to the collaboration space with a shared writing page for each breakout group (slide show).
Data structures	One collaboration space with a shared writing page for each breakout group (e.g. slide show) and access to read and copy solution aspects from the shared writing page from the step before.

Behavior	
Process restrictions	To reduce cognitive load, learner behavior is restricted as follows:
Technology restrictions	Learners get automatic access to the collaboration space with the shared writing page (slide show). On the shared writing page, learners have restricted rights for editing; when the time is over, the rights switch such that they only can read the reported solution.
Guidance restrictions	Learners receive relevant information for the current step. They receive instructions to get access to the task by opening the shared writing page, and when the time is over to close the document to finish the collaborative activities.
Training restrictions	None. Walkthrough video was provided in the step 2.
Transitions (Conditions to pass this step)	
Changes of data	Each breakout group receives a document that allows report the solution (e.g. slide show).
Changes of orientation	Synchronous. Learners remain in their breakout group. They receive: a) feedback about which step they are in; and b) after their activities, whether they have passed the step.
Changes of capabilities	Learners receive a hint that they are allowed to open and edit the shared writing page, and after the available time that they can only read the document.

Table 56: **Step 5: Reporting – Breakout Groups (Synchronous)**
Source: own illustration

6.3.7 The HLL Reference Process Methodology (HLL Methodology)

This section presents the HLL Methodology. The aim of the HLL Methodology is to empower lecturers to build their own exemplary instances of the HLL Reference Process. First, the HLL Methodology provides lecturers with an overview of the HLL Process in general and its required tool support (see Table 57). Second, the HLL Methodology describes *constraints* a lecturer has to ensure in order to run and instantiate the HLL Process and to build a HLL-PSA. Those constraints address an overview of the collaborative learner activities, the minimum and maximum class size, the minimum duration of the HLL experience, and the collaboration modes. Third, the HLL Methodology describes the *scope and content a lecturer has to prepare* to build an exemplary instance in the form of an HLL-PSA.

6.3.7.1 Overview of the HLL Process

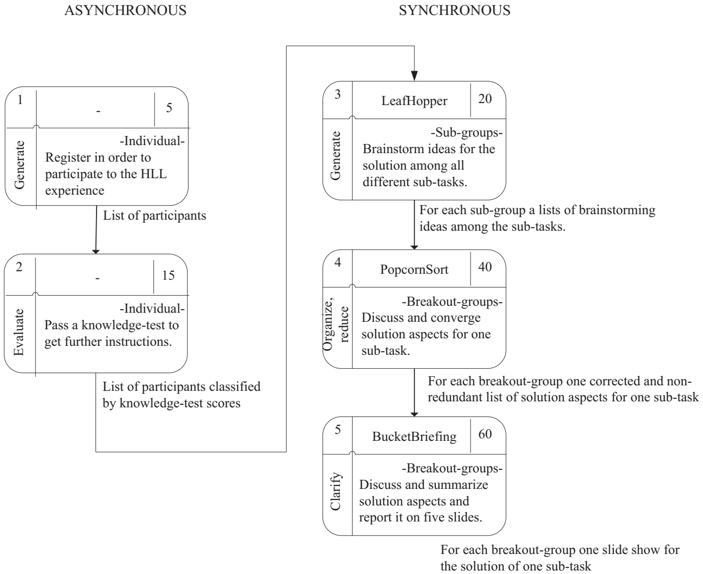
Type of Tool Support	Per participant, a laptop with internet access, Learning Management System (LMS) with functionalities for registration, quiz, separated groups. Collaborative working space with shared writing pages (e.g., Google Docs, Google Slides).
Collaborative Outcome	Per subtask (breakout group), a correct and well-structured solution on 5 slides representing a mental construction of domain knowledge concepts from multiple sources that form a new, integrated, and meaningful domain knowledge concept.
Facilitation Process Model[13]	

Table 57: **Overview of the HLL Process**
Source: own illustration

6.3.7.2 Constraints of the HLL Process to Build a HLL-PSA

To run the HLL Process in a large class university setting, a lecturer has to ensure the following constraints:

Minimum class size: The class size must be at least 4 learners. This allows building one subgroup with two breakout groups. Each breakout group will have two learners.

[13] For detailed information see section 2.2.4.

Maximum class size: The maximum class size needs to be classified along the group modes.

- *Plenary group*: The size of the plenary group is limited only by room size. The HLL Process is scalable up to 1,000 learners. Within the plenary group, only a selection of the solutions from the collaboration will be discussed.

- *Subgroup*: The size of a subgroup should not be beyond 24 learners. A subgroup consists of several breakout groups. The number of breakout groups depends on the number of subtasks. There should not be more than four subtasks, because the cognitive load in the brainstorming activity (step 1) might increase beyond this number of subtask. Even though brainstorming activities allow larger numbers of participants, it is important to avoid information overload by too many contributions or distraction by other learners in order to ensure concentrated activities (Valacich et al. 1993a). Based on that number of subtasks and a maximum breakout group of six, the maximum size of a subgroup should not be more than 24 learners.

- *Breakout groups*: The size of breakout groups should not be more than six, since beyond this number the group productivity will decrease (Ingham et al. 1974).

Collaboration modes: It is important to respect the following aspects of collaboration modes to run the HLL Process:

- *Synchronous collaboration*: The collaboration for solving a task should take place synchronously because this will allow same-time interactions. Learners will receive direct responses to their activities from their teammates. Moreover, this will reduce the cognitive load, since learners work focused on the solution of a subtask. In cases of an asynchronous collaboration learners would always need time to become acquainted with the current status of the solution.

- *Face-to-face collaboration (plenary group):* The plenary group with all students will meet in the lecture to discuss the solutions from the small group collaboration of the HLL Process.

- *Remote collaboration (subgroups, breakout groups):* The collaboration for solving the subtasks takes place in subgroups and breakout groups. It is remote, because the learners should not be distracted by each other. This way they will have the chance to reflect on the knowledge and contributions on their own.

Moreover, the bottom learners will have the chance to acquaint themselves with the learning content and the knowledge contributions from their teammates without receiving social pressure to make a contribution.

- *Identity*: The learners should not make their contributions anonymously. Since the collaboration takes place remote, this will prevent learners from making contributions that are not meant seriously. Moreover, this will contribute to a positive group atmosphere, since learners will see who makes contributions and thus, prevents from freeriding behavior.

- *Teammates*: To ensure awareness and prevent freeriding behavior, a list of the teammates of each group should be presented.

6.3.7.3 Scope and Content of the HLL Process to Build a HLL-PSA

To run the HLL Process and build a HLL-PSA a lecturer has to make the following preparations:

1. *Define Learning Objectives:* The learning objectives of the HLL Process refer to the top layers of Bloom's revised taxonomy (apply, analyze, evaluate, create). Those learning objectives drive the choice of the teaching case and its subtasks.

2. *Set the Duration of the Learning Experience:* Generally, the duration of the HLL Process should last between 2 to 3 hours. On the one hand, this is the typical time of a university lesson. On the other hand, a shorter duration will not be sufficient to reflect on knowledge concepts in its total complexity. To attain higher-level learning students must deal with the case, debate potential solutions, explain concepts to one another, build consensus, and create a group deliverable.

3. *Create a Learning Stimuli and Choose a Teaching Case:* To teach business students lecturers need to prepare a real-world problem in the form of a case study comprised of several subtasks; each referring to a specific topic of domain knowledge. The collaborative task should focus on the specific domain knowledge and challenge the learner with a real-world problem in the form of a case. The case describes a real-world problem and the context of domain knowledge. The case is divided into several independent subtasks, each with a question that challenges the learner to apply, analyze, evaluate, and create domain knowledge. Ultimately the solution is reported in a well-structured way so that it represents higher-level domain knowledge (e.g., creating relationships among knowledge chunks).

a) The teaching case should require a minimum of two and a maximum of four independent subtasks that can be executed by breakout groups of 2–6 students working in parallel.

   i. *Minimum*: A minimum of two subtasks is important, because learners should work on different subtasks.

   ii. *Maximum*: A maximum of four subtasks is important, because brainstorming on four different tasks will balance the cognitive load for an individual learner. Focusing on more than four subtasks in parallel will decrease the level of concentration. Thus, brainstorming on more than four subtasks would dilute the quality and quantity of ideas. Moreover, it will become difficult to discuss more than four subtask solutions in final plenary.

   iii. *Working in parallel*: The teaching case with its subtasks must have a structure that allows learners to work in parallel on all subtasks. That means the subtasks should not build on each other in a way that the solution of task 1 builds necessary input to solve tasks 2. Working parallel on all subtasks will support scalability aspects of the HLL Process. It is important to divide the case into several subtasks for several reasons. There is little likelihood that one person working in parallel on all the subtasks will achieve attainment with its individual goals. Reasons are that it is not possible for one person alone to create a solution for all subtasks during the available time; and working on all the subtasks would increase a learner's cognitive load. Therefore, a learner discusses and reports only the solution for one of the subtasks within a breakout group.

   iv. *Plenary discussion*: With respect to a high goal utility – receiving the solutions of all subtasks – a learner has the chance to get those solutions as well by participating in a follow-up learning activity within the plenary group in the classroom. During that follow-up learning activity for each subtask a selection of the solutions becomes presented and discussed (e.g. whether there are mistakes in the solution). Since one learner only knows the solution for one subtask, the discussion quality in the classroom will be enriched. By working in small groups the individual efforts for a learner are reduced, but also allow for high goal attainment since a learner receives all solutions.

b) Moreover, subtasks should require student deliverables that realize the learning objectives. Domain knowledge at higher levels is complex; it is challenging to explain and report this knowledge in an abstract way that is easy to understand. However, an explanation can be presented in a report, which in turn indicates a deep and sophisticated understanding of the domain knowledge and its relationships. Thus, each breakout group has to create a group deliverable: a slide show that reports the solution for one subtask. In that context, the creation of a slide show forms a new, integrated, and meaningful domain knowledge concept.

c) Students should be able to complete it within the prescribed duration.

4. *Specify Student Deliverables:* To run the HLL Process in a large university class, lecturers have to specify the type and structure of the group deliverable. It is important that the group deliverables have a format that is easy to present in the plenary discussion. Otherwise the plenary discussion would not run and the learners would not receive the solutions from the other tasks.

6.3.8 The HLL Process Support Application (HLL-PSA)

In the following I describe the HLL-PSA. This is the prototypical implementation of the HLL Process. In order to evaluate the real-world feasibility of the generalizable solution, DSR requires that researchers develop an exemplar instance. In this section I therefore describe the HLL-PSA, an exemplar instance of the HLL Process. As tool support it uses as LMS Moodle and as shared writing pages Google Docs and Google Slides. To illustrate the HLL-PSA I summarize key aspects of the several steps.

6.3.8.1 Characteristics of the Case, Learning Tasks, and Learner Deliverable

Defining the learning task helps to guide the collaboration among learners. In the context of the HLL-PSA this is specified as follows: *Synchronously and within three hours, small learner groups develop, clarify, and discuss a solution for one subtask from a case and report it on a slide show with five slides in a structured, correct, and comprehensive way that represents a new, integrated, and meaningful domain knowledge concept.*

The learning task involves a case with four subtasks (see Appendix 4). The case describes a real world problem in the form of a company struggling with its digital transformation. Each of the corresponding subtasks addresses specific aspects of domain knowledge:

- *Subtask 1* - Illustrate model-based problem-solving with an example for implementing an online payment system into a trading company;
- *Subtask 2* - Develop a reference model for online payment procedure in a small trading company;
- *Subtask 3* - Explain applications of CRM in a company, and the relationship between CRM and ERP;
- *Subtask 4* - Explain ERP implementation in a trading company and describe the benefit of ERP within the SCM and to represent the relationships among the concepts in a jointly-authored document.

6.3.8.2 Specifics of the Breakdown Structure of Groups

To solve the case, I create four breakout groups (of 6 learners each), which together form one subgroup (of 24 learners).

- Subgroups (each with four breakout groups) receive all four learning tasks.
- Each breakout groups receives only one learning task (subtask).

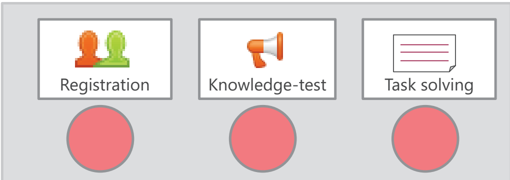
I choose Moodle, Google Docs, and Google Slides as tool support. Moodle serves as a LMS for creating separate groups and unlocking individualized activities from steps 1 to 5 (registration, knowledge test, brainstorm, converge, and report). To initiate synchronous collaboration, Google Docs and Google Slides serve as collaborative working spaces that provide shared writing pages. This ensures that learners only get access to the relevant information for the current step.

After a learner has passed a step, information for the next step is unlocked automatically in Moodle. For steps 3-5, Moodle provided each group a specific link to their shared writing page (Google Docs, Google Slides) for their assigned task. This way, every learner receives a customized and individual learning experience with no cognitive information overload. This way, Moodle takes over most of the moderation and guides the learners through the collaborative activities. In addition to the subsequent brief descriptions of each step of the HLL-PSA, a detailed description of the instructions per step is outlined in Appendix 6).

6.3.8.3 HLL-PSA - Step 1: Registration – Individual (Asynchronous)

Moodle provides information about participating in the HLL experience in the form of a walkthrough video and a registration (Table 58). The tutorial video shows learnres how to use the functionalities of Google Docs and Slides for collaborating with each other. To pass step 1 is limited to a defined date and is a prerequisite to get access to the next step (step 2).

Tool: Moodle



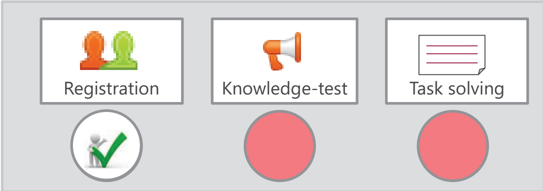
Instructions	Date how long registration is open; How registration works.
Training	Link to walkthrough video
Registration	Link with one selection option.

Table 58: HLL-PSA - Step 1: Registration – Individual (Asynchronous)
Source: own illustration

6.3.8.4 HLL-PSA - Step 2: Knowledge Test – Individual (Asynchronous)

If a learner has successfully has passed step 1, a green checkmark and further information appear that give him feedback that he is now a participant of the HLL experience. Otherwise neither a checkmark nor further information will appear. In case of a successful registration, learners get a link to access the knowledge test, the knowledge test instructions, and a deadline before which the knowledge test must be passed (Table 59). Passing the knowledge test is a prerequisite to access the next step (step 3).

Tool: Moodle



Instructions	Feedback of being participant. Date how long test is available; How knowledge test works.
Knowledge test	Link to open knowledge test (True-false questions)

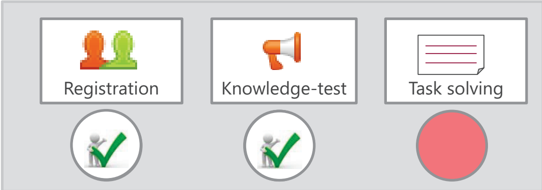
Table 59: HLL-PSA - Step 2: Knowledge Test – Individual (Asynchronous)
Source: own illustration

6.3.8.5 HLL-PSA - Step 3: Brainstorming – Subgroups (Synchronous)

In the form of a green checkmark in Moodle, each learner receives feedback that he passed the knowledge test and receive further instructions for step 3 (Table 60). Depending on the knowledge test scores, in Moodle learners are assigned to knowledge-heterogeneous breakout groups, each consisting of half top and half bottom students. Four breakout groups constitute one subgroup. Before the synchronous collaboration, all learners receive a reminder of the date of the synchronous collaboration and a checklist with tips for preparation (e.g. have a computer with internet access; be online 15 mins before the collaboration starts). On the date of the synchronous collaboration, learners receive in their groups (subgroup, breakout group) in Moodle access to further information and instructions (e.g., a figure showing the next three steps, a table with an overview of the group members). In each subgroup, a link is unlocked that guides the learners to their shared writing page in the form of a Google Docs.

This document contains the description of the case and its four subtasks, as well as instructions on how to brainstorm ideas for solving each of the subtasks. After 20 minutes, the document's editing rights become restrictive; learners can no longer write in or change the document, they can only read it. A red box appears in the Google Docs that guides the learners back to Moodle for getting access to the next step.

Tool: Moodle

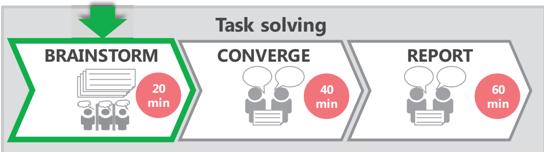


Reminder	Date of synchronous collaboration;
Checklist	(e.g. prepare computer with internet access, make a check of IT-tools)

- -

Overview	Steps 3-5
FAQ	- Functionalities for collaboration.
	- Table subgroup members.
Brainstorming	Link to Google Docs.

Tool: Google Docs



Each subgroup one Google Docs

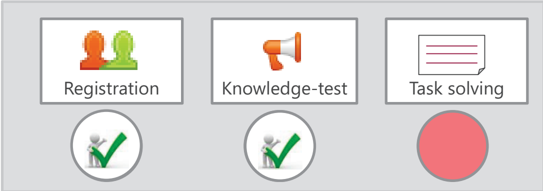
Instructions	How to collaborate (see Appendix 6);
	How to move to the next step (see Appendix 6);
Case	Description (see Appendix 4)
4 Subtasks	Description (see Appendix 4)

Table 60: HLL-PSA - Step 3: Brainstorming – Subgroups (Asynchronous)
Source: own illustration

6.3.8.6 HLL-PSA - Step 4: Converging – Breakout Groups (Synchronous)

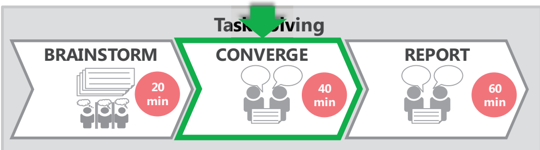
After 20 minutes, Moodle unlocks in every breakout group the information for step 4 (Table 61). Now, each subgroup is automatically divided into four breakout groups. Learners receive a table with their breakout group members as well as a link that guides them to their Google Docs to collaborate with each other. Every breakout group works on one of the subtasks. The Google Docs for converging activities comprises the case description and the one assigned subtask including the brainstorming ideas from the step before. The Google Docs also contains instructions on how to converge the previously brainstormed solution ideas among the categories of correct aspects; false aspects; summarized aspects). After 40 minutes, the editing rights on in the Google Docs become restrictive; learners can no longer write in or change the document, they can only read it. A red box appears in the Google Docs that guides the learners back to Moodle for getting access to the next step.

Tool: Moodle



FAQ	- Functionalities for collaboration. - Table breakout group members.
Converging	Link to Google Docs

Tool: Google Docs



Per breakout group one Google Docs

Instructions	How to collaborate (see Appendix 6); How to move to the next step (see Appendix 6);
Case	Description (see Appendix 4)
One Subtask	Description (see Appendix 4)

Table 61: HLL-PSA - Step 4: Converging – Breakout groups (Synchronous)
Source: own illustration

6.3.8.7 HLL-PSA - Step 5: Reporting – Breakout Groups (Synchronous)

After 40 minutes, Moodle unlocks the information for step 5 (Table 62). Learners remain in their breakout group and a link guides them to the reporting Google Slides. The shared writing page for reporting activities comprises the case description with one of the subtasks. The learners receive instructions on how to report their solution on five slides. After 60 minutes, the document's editing rights become restrictive; learners can no longer write in or change the document, they can only read it.

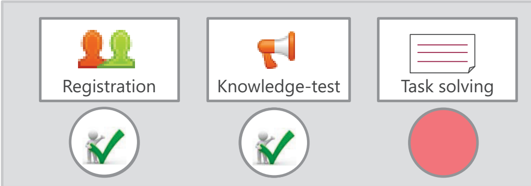
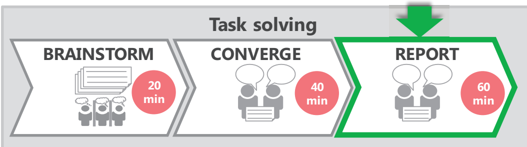
Tool: Moodle	
	
FAQ	- Functionalities for collaborating - Table breakout group members
Reporting	Link to document
Tool: Google Slides	
	
Per breakout group one Google Slides	
Instructions	How to collaborate (see Appendix 6); How to move to the next step (see Appendix 6);
Case	Description (see Appendix 4)
One Subtask	Description (see Appendix 4)

Table 62: **HLL-PSA - Step 5: Reporting – Breakout Groups (Synchronous)**
Source: own illustration

6.3.9 Validating the HLL Design Theory

This section examines the degree to which the HLL Design Theory achieves its two primary design goals: to enhance HLL for large-class contexts; and to package sufficient collaboration expertise in the process-design so that non-experts (learners) can execute a well-designed work practice without training on tools or techniques. The HLL-PSA was implemented in the field and served as artifact for the evaluation. First, I describe the research method used for evaluation. Second, I derive exploratory research questions to figure out whether the solution meets the design goals. Third, I outline the results of my study vis a vis my exploratory research questions.

6.3.9.1 Requirement-Based Evaluation

Before conducting an evaluation in the field by using the HLL-PSA, the quality of the HLL Process as generalizable solution is first assessed by conducting a requirement-based evaluation. This is in line with Hevner et al. (2004a) and Hevner (2007), and serves as the evaluate part that completes the design cycle. Table 63 outlines the GR derived from practice and literature and how they are addressed by the HLL Process.

GR	HLL Process addresses the GR as follows:
GR0. Influencing Group Behavior by Group Size	This requirement is addressed. The HLL Process allows breakout groups from at least two up to six learners.
GR1. Task Complexity	This requirement is addressed in the steps 3, 4 and 5 by which the learners build new relationships among domain knowledge concepts and create new domain knowledge in the form of reporting the solution (e.g. in the form of a slide show). The steps 1 and 2 constitute a necessary preparation to initiate the synchronous collaboration for enhancing HLL in the subsequent steps.
GR2. Generating Shared Knowledge Base	Step 3 helps less knowledgeable learners to expand their domain knowledge by reading the contributions from more knowledgeable learners. This helps to generate a shared knowledge base for enriching the discussion quality with other learners in the subsequent steps. During step 4 the learners challenge and clarify their solution ideas and report the shared solution in step 5.
GR3. Ensuring Reciprocity	The difficulty of the learning experience increases from steps 3 to 5 since the level of knowledge increases. For that reason, all learners have to work together in order to generate a solution in the available time. In step 3, bottom learners have the chance to benefit from top learners by expanding their domain knowledge through reading the top learners' contributions. During the subsequent steps, all learners – even the top learners – challenge each other (e.g., with clarification questions).
GR4. Providing Rapid Feedback	In each step, the learners receive feedback regarding which step they are in, how to move forward, and how to interact with each other. Since the learners have only restricted time to solve the tasks during the synchronous collaboration, intensive interaction with each other is necessary. In step 4, learners correct the solution ideas within their breakout group. This ensures rapid feedback on their collaborative activities and results.
GR5. Respecting Flexibility	The HLL Process does not depend on a certain knowledge domain and is not restricted to a defined number of learners. It is designed to empower lecturers to teach business students in large classes by teaching learning content of their choice by using a teaching case. The lecturers only need to prepare a respective case with subtasks.
GR6. Leveraging Available Personnel	The scalability of the HLL Process is high, since it uses IT-supported tools to initiate collaborative activities among learners. The use of a LMS with e.g., separated group functionalities and condition-based functionalities for unlocking information / instructions takes over most of the moderation efforts. Thus, an instructor is able to moderate a large number of synchronous collaborating breakout groups.
GR7. Leveraging Available Resources	Most universities use a LMS with wide range functionalities allowing the use of the HLL Process. There are also open-source LMS (e.g. Moodle).

GR8. Ensuring Transferability	While the configuration of the LMS and the shared writing pages constitute the most time-consuming effort, the moderation efforts for running the HLL Process are minimal. Besides that, most universities provide instructors with helpdesk-support services for using the LMS. Thus, instructors do not need additional training.
GR9. Minimizing Cognitive Load GR10.Prescribed Procedures	Along steps 1-5, there are process restrictions (technology, guidance, and training restrictions) that lead learners through a HLL experience. This helps to reduce all distractions to a minimum (e.g., learners do not spend effort in grouping activities, since they are assigned to groups automatically).
GR11. Influencing Cognitive Resources by Breakout groups	The HLL-Methdology helps lecturers to divide the plenary group into breakout groups.
GR12. Heterogeneous Learning Groups	Step 2 of the HLL Process refers to a knowledge test. This activity is essential to build knowledge-heterogeneous breakout groups depending on the knowledge test performance.

Table 63: Requirement-Based Evaluation
Source: own illustration

6.3.9.2 Study Structure of the Online Quasi Experiment

To validate the HLL Design Theory and more precisely the implementation of the HLL Process as HLL-PSA in a real world large class setting, experimental techniques were used to determine exploratory insights into whether the solution meets the primary design goals. Using experimental techniques, I arranged two experimental samples:

- *Treatment Sample (with HLL-PSA):* Those learners experienced the before systematically designed structured collaboration of the HLL-PSA.
- *Control Sample (without HLL-PSA):* Those learners used the same tools as the learners in the treatment sample. However, they were free in their collaboration and thus, experienced a typical constructivist learning experience by which they had to invent ad hoc collaboration.

Background and Context of the Participants

The HLL-PSA was validated during the fall semester 2015/16 at a German university in a large class on the principles of information systems attended by 150 undergraduate business students. The HLL-PSA was offered as a voluntary HLL-experience, a technique for training learning content to achieve higher levels of domain knowledge and improve higher-level thinking skills. It was announced by a call for participation in the lecture hall and in the Moodle course. In total, 104 undergraduate students registered for the HLL-experience without knowing whether they would be in the treatment or control sample.

Selection of Participants

As an incentive, students who decided to participate in the HLL-experience as well as completed an online pre-evaluation (knowledge test) and an online post-evaluation (knowledge test and survey) received up to 4 bonus points for the final exam. In total, 101 students (31 males, 70 females, aged 19-39 years [mw=23 years; SD = 3,2]) completed the pre-test and post-test.

Case study and Subtasks

To conduct the online quasi experiment of the HLL-experience with the learners a case study comprising four subtasks was assigned to the learners. This is the case study that is part of the HLL-PSA (see Appendix 4).

Data Triangulation

To validate the HLL-PSA, I used a data triangulation. I conducted the HLL experience for one time during the semester, and collected data from two audiences:

1) *Data from learners:* to gain insights on the changes of learners' LLL expertise as well as their satisfaction in participating in the HLL experience, a pre- and post-knowledge test (see Appendix 5) and a survey (see Appendix 8) were conducted. For detailed descriptions, see section 6.3.9.4.

2) *Data from independent lectures:* To gain independent insights on learners' LLL and HLL performance, an evaluation of the collaborative outcome – the slide show solutions – by independent lecturers was conducted after the HLL experience. For detailed descriptions, see section 6.3.9.4

Experimental Procedure

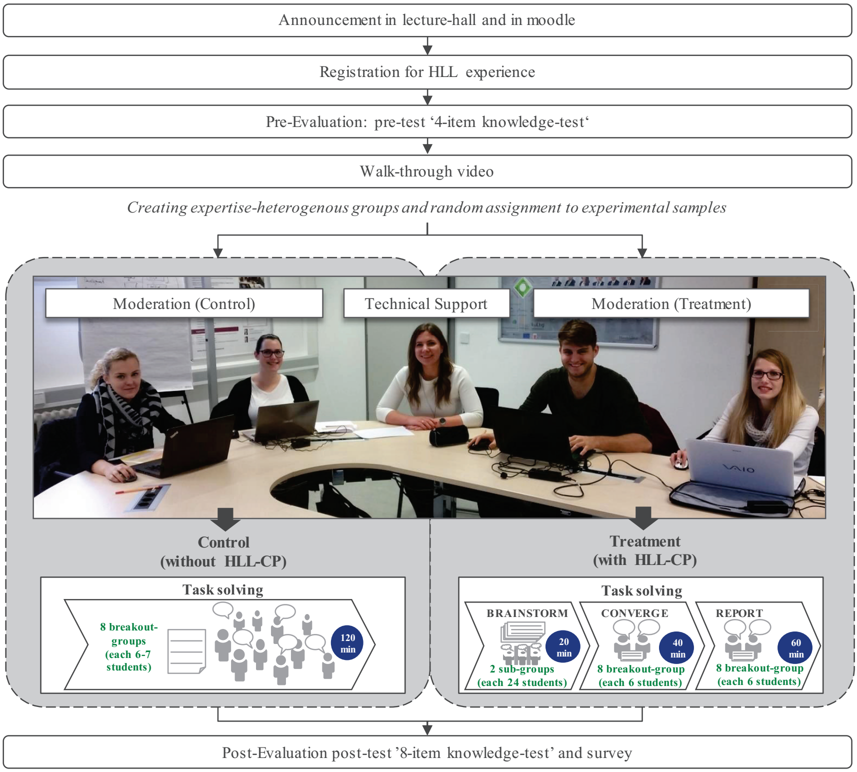


Figure 29: Procedures of the Online Quasi Experiments
Source: own illustration

Figure 29 illustrates the experimental procedures. *First*, there was a call for participation in the HLL-experience by an announcement in the lecture hall and in the Moodle course. *Second*, learners registered for the HLL-experience. *Third*, they got access to a knowledge test. *Fourth*, based on the knowledge test performance the learners were assigned into two samples (treatment and control). *Fifth*, one day before the synchronous collaboration of the HLL experience, all learners received the same 2-minute walkthrough video explaining the technical functionalities of Google Docs and Google Slides. *Sixth*, at the day of the synchronous collaboration the learners used their own computers. The learners did not know whether they are in the control or the treatment sample. Also the control sample received all instructions by Moodle. During the collaboration both samples were observed each by two moderators and one person that provided technical support (see Figure 29). Each moderator observed the activities of one subgroup (4 breakout groups). The moderation efforts were less and served more or less as backup in cases that the whole HLL-experience might have been collapsed. *Seventh*, at the end of the collaboration, all learners were asked to do an online post-evaluation, comprising a post-test and a survey.

6.3.9.3 Differences Between the Control and Treatment Sample

After the learners received the walkthrough video, the way of collaboration was manipulated and the learners were assigned to two samples.

Each sample comprised 8 expertise-heterogeneous breakout groups. Using their performance scores from the pre-test (worst = 0 to best = 4), learners were categorized as top learners and bottom learners. Then a spreadsheet was used to randomly assign three top learners and three bottom learners to each of 16 breakout groups (treatment: N= 48; control: N=56). The control breakout groups had a seventh member because the number of participants was not evenly divisible by 16. This had the potential to skew performance measures in favor of the control breakout groups because research shows that, with collaboration technology that permits simultaneous input by all participants, group productivity increases with group size, at least up to groups of 30 (Dennis/Valacich/Nunamaker 1990; Gallupe 1992; Valacich et al. 1993b). However, because all were in the control condition, they would not bias the results in favor of the solution I were testing, rather making it harder for us to show the value of our treatment. To verify that the stratification process produced subject pools with approximately equal levels of ability, I compared the distributions of pre-test scores by assigned experimental sample with a Mann Whitney U test. There was no statistically significant difference in the distribution of pre-test scores by experimental sample assignment (U=1076.5, p=0.171), which suggests that the treatment groups started with no bias with respect to lower-level knowledge. To control for potential differences in task difficulty, in both samples (treatment and control), each of the subtasks was assigned to two breakout groups. After the study, a one-way ANOVA revealed a statically-significant difference in task difficulty. A post-hoc Bonferroni test revealed no differences in difficulty for subtasks 1, 2, and 4. Subtask 3, however, was significantly more difficult than subtask 1. That difference, however, was balanced across treatments.

Depending on being in the treatment or control sample, Moodle unlocked different information, instructions, and links to the shared writing pages (Google Docs, Google Slides) for the learners. The manipulation of the two samples is characterized by the following aspects outlined in Table 64.

Manipulation of the collaboration	**Treatment Sample (with HLL-PSA)**	**Control Sample (without HLL-PSA)**
Process restriction 'guidance'	*High* Collaborative activities were restricted in that learners were guided on how to collaborate and were restricted in the use of technology (e.g., editing rights of the documents changed.).	*Low* Collaborative activities were almost unrestricted in that learners had the chance to invent ad hoc collaboration and were free in the use of technology (e.g., no changes of editing rights in documents).
Instructions (time and type)	*Step-by-Step* Focused on how to collaborate with each other as well as outlined the expectations for a good solution (see Appendix 6).	*Full instruction at the beginning* Outlined expectations for a good solution (see Appendix 7).
Amount of shared writing pages	*2 Google Docs, 1 Google Slides* - Google Docs – BRAINSTORM; - Google Docs – CONVERGE; - Google Slides – REPORT.	*1 Google Docs, 1 Google Slides* - Google Docs – DISCUSS; - Google Slides – REPORT.
Number of group changes	*1 (subgroup → breakout group)* Learners were initially assigned to a subgroup in which they had to brainstorm solution ideas for all four subtasks and then to one breakout group with one subtask.	*0 (breakout group)* Learners were directly assigned to a breakout group that only received one subtask.

Table 64: Differences between Treatment and Control Sample
Source: own illustration

6.3.9.4 Measures

Figure 30 outlines an overview of the measures used to validate the HLL-PSA. Data was collected using an online pre-evaluation (pre-test '4-item knowledge test) and post-evaluation (post-test '8-item knowledge test') done by learners as well as a post lecturer's assessment of group deliverables.

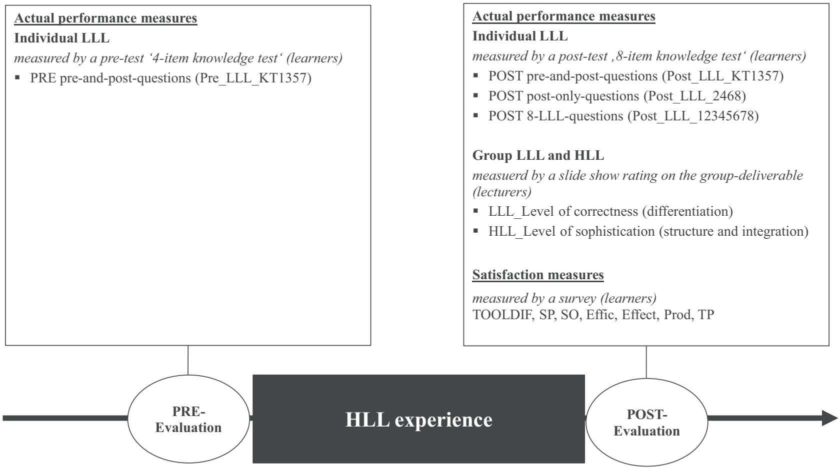


Figure 30: Overview of Measures
Source: own illustration

Actual Performance Measures

Actual individual performance (LLL) measures by pre-test and post-test: Learners had to complete a 4-item pre-test and an 8-item post-test. The test questions refer to aspects of LLL (see Appendix 5). The pre-test comprised four true-false-questions, each with a reference to one of the four subtasks from the case. The post-test comprised eight true-false-questions: the same four ones from the pre-test, plus four new true-false-questions, each with a reference to one of the four subtasks from the case. To answer the questions, a two-point 'true/ false' scale was used.

Actual group performance (LLL, HLL) by group deliverable lecturer assessment: Five treatment-blind, independent raters evaluated the group deliverables (i.e., learners' slide shows). The raters were lecturers who teach information systems at universities. Two variables are used: *Level of correctness [differentiation]* refers to aspects of LLL; and *Level of sophistication [structure & integration]* refers to aspects of HLL (Table 65). The interrater reliability for these assessments as measured by Cronbach's Alpha was 0.85.

Variable	Description and Items
(1) Level of correctness for measures on LLL.	To assess the degree to which participants had attained LLL, the raters evaluated the level of correctness of the domain knowledge represented in the students' slide show deliverables. This refers to the number of distinct dimensions of a problem. To evaluate the slide show, the raters used a questionnaire with a seven-point semantic rubric: (1) = The group did not submit a solution; (2) = Amount of correct aspects is 0%; (3) = 20%; (4) = 40%; (5) = 60%; (6) = 80%; (7) = 100%.
(2) Level of sophistication for measures on HLL	To assess the degree to which participants had attained HLL, the raters evaluated the level of sophistication of the domain knowledge represented in the learners' slide show deliverables. This refers to the development of complex connections among differentiated characteristics. Evaluators used a seven-point semantic rubric: *The group did not submit a solution*; *No visualizations of relationships among concepts:* Some content copied verbatim from the textbook or supplementary learning material. Few concepts presented. Long, unfocused phrases. No connections among concepts represented; *No visual representation of relationships concepts:* Concepts presented in the students' own words. Phrases are more focused, but still tend to be long and complicated. Very few connections among concepts represented; *No visual representation of relationships among concepts*: Phrases are briefer and more focused, but still not completely clear. Few connections among concepts; *Nothing visualized*. Clear phrases. Moderate number of connections among concepts; *Some relationships visualized:* Clear, concise phrases. Many connections among concepts; *Strong visualization of relationships:* Clear, concise phrases. Most or all of the complex connections among concepts represented.

Table 65: Actual LLL and HLL by Group Deliverable Lecturer Assessment
Source: own illustration

Satisfaction Measures

Most of the following exploratory variables (Table 66) were adapted from previously published multi-item semantic anchor scales. The originals were all written in English. A native German speaker translated all questions to German. Some of the items had seven-point semantic anchor questions, while others had five-point semantic anchor questions. I converted the five-point questions to seven-point questions to increase discrimination. Appendix 8 outlines full text of the German and English versions.

VARIABLE	DESCRIPTION
Tool Difficulty (TOOLDIF).	To measure whether the HLL-PSA tools imposed undue cognitive load on the learners, a five-item scale from Briggs et al. 2013(2013) was adapted. Preliminary analysis of construct validity suggested that the first question in the set did not load well with the others. That question asked about levels of comfort with the tools, while the others asked how easy or difficult experiences with the tool were, suggesting the first question measured a different but related construct. We therefore dropped the first item. Cronbach's alpha for the new four-item scale was 0.86 as measured by Cronbach's Alpha.
Satisfaction with process (SP).	To measure whether the line of action of the HLL-PSA created a feeling of satisfaction by the learners, we adapted a five-item scale from Briggs et al. 2013 (2013). Preliminary analysis of construct validity suggested that the first question in the set did not load well with the others. That question asked about the satisfaction with the moderation by which the HLL-PSA was conducted, while the others asked for the satisfaction about the procedures and way the HLL-PSA was conducted. Suggesting that the first question measured a different, but related construct, we therefore dropped the first item. Cronbach's Alpha for new four-item scale was 0.88 as measured by Cronbach's Alpha. To answer the questions, a seven-point semantic rubric was used (1-strongly disagree / 7-strongly agree).
Satisfaction with outcome (SO).	To measure whether the outcome of the HLL-PSA imposed a feeling of satisfaction by the learners, we adapted a five-item scale from Briggs et al. 2013 (Briggs et al. 2013). Cronbach's Alpha for the five-item-scale was 0.94. To answer the questions, a seven-point semantic rubric was used (1-strongly disagree / 7-strongly agree).
Efficiency (Effic).	To measure whether participating in the HLL-PSA by putting time and effort created by the learners feelings of adequate and self-worth, we adapted a five-item scale from Kolfschoten 2007 (Kolfschoten 2007). Cronbach's Alpha for the five-item scale was 0.86. To answer the questions a seven-point semantic rubric was used (1-strongly disagree / 7-strongly agree).
Effectiveness (Effect).	To measure whether participating to the HLL-PSA imposes an outcome that complies with learners' expectations, we adapted a five-item scale from Kolfschoten 2007 (Kolfschoten 2007). Cronbach's Alpha for the five-item scale was 0.91. To answer the questions, a seven-point semantic rubric was used (1-strongly disagree / 7-strongly agree).
Productivity (Prod).	To measure whether participating in the HLL-PSA imposed a positive feeling between the own efforts in relation to the group outcome, we adapted a seven-item scale from Kolfschoten 2007 (Kolfschoten 2007). Cronbach's Alpha for the five-item scale was 0.83. To answer the questions a seven-point semantic rubric was used (1-strongly disagree / 7-strongly agree).

Perceived Team Performance (TP).	To measure whether the HLL-PSA imposed a positive team atmosphere that helped to enhance constructive interactions, we adapted a three-item scale from Benalian 201X (Benalian 201X). Preliminary analysis of construct validity suggested that the second question in the set did not load well with the others. That question asked about team effectiveness, while the others asked about the way of collaborating with team members. Therefore, we suggest the second question measured a different but related construct and thus, dropped the second item. Cronbach's Alpha for the new four-item scale was 0.89. To answer the questions, a seven-point semantic rubric was used (1-strongly disagree / 7-strongly agree).

Table 66: Satisfaction Measures
Source: own illustration

6.3.9.5 Hypothesis and Exploratory Research Questions

To analyze the effects of the HLL-PSA in relation to my design goals, I provide in this section my main hypothesis, as well as exploratory research questions. In particular, I focus on the effect of my HLL-PSA on the dependent variables:

- Group performance measured by lecturers' slide show assessment (level of correctness [LLL], level of sophistication [HLL]) and,
- Individual performance measured by pre-test and post-test [LLL].
- Other exploratory dependent variables focus on learners' satisfaction in participating in the HLL-experience.

Cognitive learning theory posits HLL occurs when related concepts are juxtaposed with the nature of their relationship in sufficient frequency and duration that they are chunked into a single frame comprising related concepts. The learning task (Appendix 4) required that students work together to create a deliverable that communicates a set of concepts and the relationships among them. The steps 3 to 5 in the engineered HLL-PSA foster actions that would juxtapose concepts and relationships in working memory. Besides that, students are unlikely to invent ad hoc collaborative processes optimized in that way. I therefore hypothesize that:

H1 Groups of students who participate in the engineered HLL-PSA will score higher on the HLL 'level of sophistication' (create a document representing relationships among domain knowledge) than students who conduct unstructured collaboration.

To further analyze the effects of applying PL in general and my HLL-PSA in particular beyond the hypothesized HLL effect, I derive the following exploratory research questions.

Overall effects on LLL: First of all, I want to investigate whether PL – regardless of following a structured collaboration methodology or not – will lead to an increase in the LLL of the participants. I would expect to observe an increase in expertise in both samples, since the participants were able to reflect and discuss their LLL knowledge with other learners. To assess whether there are overall LLL effects regardless of the treatment or control sample, pre- and post-test scores were used to measure the individual performance before and after the HLL-experience. Subsequent to the collaborative activities of the HLL-experience, students completed an eight-item post-test comprising eight true-false questions. Four of the eight questions on the post-test were the same questions they had seen in the pre-test, and so we call these the 'pre-and-post questions'. Since different scores in the 'pre-and-post questions' might be attributed to priming, I added four more questions they had not previously seen to the post-test; I call these the 'post-only questions'. In the post-test, comparable scores in the 'post-only questions' and in the 'pre-and-post questions' will further indicate that LLL learning can be observed. This leads to the following exploratory research questions:

Q1 Did students score better on the four 'pre-and-post questions' in the pre-test compared to the post-test?

Q2 In the post-test, did students score comparably on the 'pre-and-post questions' and on the 'post-only questions'?

Differences in LLL by treatment: Even though my process was designed to affect HLL, the process might also have affected LLL of the participants, since the participants did not need to figure out how to collaborate effectively in parallel, but could only focus their attention on understanding and processing the learning content, and on solving the task. To assess whether there is a difference in LLL by treatment, I seek to answer the following questions regarding the LLL individual performance as well as LLL group performance working on the subtasks.

Q3 Did use of the HLL-PSA increase the individual LLL performance on the eight questions in the post-test?

Q4 Did use of the HLL-PSA increase the individual LLL performance on 'pre-and-post questions' in the post-test?

Q5 Did use of the HLL-PSA increase the individual LLL performance on the 'post-only questions' in the post-test?

Q6 Did the use of HLL-PSA increase the group performance regarding the LLL 'level of correctness' (recall about ERP facts) in the lecturer assessment?

Differences in satisfaction by treatment: Besides developing a process that increases the HLL (design goal 1) I also wanted to design a process that can be conducted by learners without needing additional support, such as from learners (design goal 2). To assess design goal 2, I investigate whether there is a difference on how the students experienced participating in the engineered HLL-PSA compared to the control sample where they can collaborate freely.

Q7 Did the use of HLL-PSA lead to a difference in the satisfaction (SP, SO, TOOLDIF, Effic, Effec, Prod, TP) by treatment?

6.3.10 Results

To ensure that learners in the treatment and control sample started with no bias with respect to LLL knowledge of ERP, I compare the mean pre-test performance of both samples. The results of a t-test (see Table 67) indicate that the LLL performance of the pre-tests by treatment is not significant. This reflects the intended randomization of creating groups of learners composed of both bottom and top learners. Consequently, both samples started with comparable levels of LLL knowledge.

	Treatment		**Control**		**t(df) = t-value**	**p-value (2-tailed)**
	N	**Mean**	**N**	**Mean**		
Pre_LLL_KT1357	47	.5479	52	.4904	t(97) = -1.166	p = 0.171
*Mean difference significant at the level *p<0.05, **p<0.01*						

Table 67: LLL Pre-Test Performance by Treatment
Source: own illustration

Design Goal 1 - Enhancing Higher-Level Learning in Large Classes

H1 focused on differences in HLL performance by treatment. I assess H1 by analyzing group performance related to HLL as measured by lecturer assessment. Table 68 reports the means, t-statistics, and p-value of the HLL group deliverable performance (HLL_LevelSophistication) by treatment as measured by lecturer assessment. The mean scores for those in the treatment sample (Mean= 5.425) are statistically significantly higher ($p < 0.01$, one-tailed) than those the control sample (Mean = 3.825). Thus, my treatment had a significant effect on the participants' ability to create an original work that expressed sophisticated relationships among the ERP concepts they learned during the study. The effect size was large, accounting for 52.4% of the variance in structural assessment scores. Thus, my data indicates that I was able to achieve my first design goal.

H_1 - Groups of students who participate in the engineered HLL-PSA will score higher on the HLL 'level of sophistication' (create a document representing relationships among domain knowledge) than students who conduct unstructured collaboration.						
	Treatment		**Control**		**t(df) =**	**p-value**
	N	**Mean**	**N**	**Mean**	**t-value**	**(1-tailed)**
HLL_LevelSophistication	8	5.425	8	3.825	$t(14) = 3.933$	$p = 0.001$*
Mean difference significant at the level *$p<0.05$, **$p<0.01$						

Table 68: Differences in HLL by Treatment
Source: own illustration

To further analyze the effects of my HLL-PSA on participants' learning, exploratory questions Q1 and Q2 focused on effects of learner's LLL performance regardless of treatment. While Q1 asked whether there are differences in the scores of the 'pre-and-post-questions' during the pre-test and the post-test, Q2 asked whether there are differences in the scores of 'pre-and-post-questions' and 'post-only-questions' in the post-test.

Table 69 presents the means, t-statistics, and p-values of the test measures of LLL. I tested the measures and found that they were statistically significant than neutral. Students had a statistically significant gain ($p < 0.05$, one-tailed) in LLL about ERP among the 'pre-and-post-questions' (LLL_KT1357), since they performed better in the post-test (Mean = 0.5644) than in the pre-test (M = 0.5099). On the post-test, I further observed a significant ($p < 0.01$, two-tailed) difference in performance on 'pre-and-post-questions' (LLL_KT1357) vs. 'post-only-questions' (LLL_KT2468). Students had better performance in the 'post-only-questions' (LLL_KT_2468 | Mean = 0.6757) than on the 'pre-and-post-questions' (LLL_KT_1357 | M = 0.5644).

Q_1. Did students score better on the four 'pre-and-post questions' in the pre-test compared to the post-test?						
	Pre-test LLL_KT1357		**Post-test LLL_KT1357**		**t(df) = t-value**	**p-value (1-tailed)**
	N	**Mean**	**N**	**Mean**		
LLL_KT1357	100	0.5099	100	0.5644	t(100) = 1.817	p = 0.036*
Q_2. In the post-test, did students score comparably on the 'pre-and-post questions' and on the 'post-only questions'?						
	Post-test LLL_KT1357		**Post-test LLL_KT2468**		**t(df) = t-value**	**p-value (2-tailed)**
	N	Mean	N	Mean		
LLL_KT1357 vs. LLL_KT2468	100	0.5644	100	0.6757	t(100) = 3.943	p = 0**
Mean difference significant at the level *p<0.05, **p<0.01						

Table 69: Overall Effects on LLL
Source: own illustration

Exploratory questions Q3 to Q6 focused on differences in LLL performance by treatment and analyzed individual performance scores measured by the post-test and group performance measured by lecturer assessment. Table 70 presents the means, t-statistics, and p-values of LLL measures of the post-test scores as well as lecturer assessment scores (LLL_LevelCorrectness). Q3 asked whether there is an increase in the LLL performance among the LLL-8-questions (LLL_Post_KT12345678) by treatment. Students in the treatment sample who followed the engineered HLL-PSA performed significantly ($p < 0.05$, one-tailed) better (Mean = 0.6622) than students in the control sample (Mean = 0.5841) who devised an ad hoc collaborative process. Q4 asked whether there is an increase in the LLL performance among the 'pre-and-post-questions' (LLL_Post_KT1357) by treatment. I did not observe a significant difference in student's performance scores on the questions they had seen previously on the pre-test by treatment. Q5 asked whether there is an increase in the LLL performance among the 'post-only-questions' (LLL_Post_KT2468) by treatment. Students in the treatment sample scored significantly ($p < 0.05$, one-tailed) higher (Mean = 0.7181) than did the students in the control sample (Mean = 0.6346) on the four 'post-only-questions' they had not previously seen on the pre-test. Q6 asked whether there is treatment-dependent increase in group performance regarding LLL 'level of correctness' as measured by lecturer assessment. I did not observe a significant difference in the group performance on LLL_LevelCorrectness between the two samples.

	Treatment		Control		t(df) = t-value	p-value
Did use of the HLL-PSA increase… *Q_3 … the individual LLL performance on the eight questions in the post-test?* *Q_4 … the individual LLL performance on 'pre-and-post questions' in the post-test?* *Q_5 … the individual LLL performance on the 'post-only questions' in the post-test??* *Q_6 … the group performance regarding the LLL 'level of correctness' (recall about ERP facts) in the lecturer assessment?*						
	N	**Mean**	**N**	**Mean**		**(1-tailed)**
Q_3 -LLL_Post_KT12345678	47	0.6622	52	0.5841	t(97) = 2.113	p = 0.0185*
Q_4 - LLL_Post_KT1357	47	0.6064	52	0.5337	t(97) = 1.539	p = 0.0635
Q_5 - LLL_Post_KT2468	47	0.7181	52	0.6346	t(97) = 1.803	p = 0.0375*
Q_6 - LLL_LevelCorrectness	8	5.625	8	5.525	t(14) = -0.362	p = 0.3615
Mean difference significant at the level *p<0.05, **p<0.01						

Table 70: Differences in LLL by Treatment
Source: own illustration

Design Goal 2 - Packaging Collaboration Expertise

The secondary design goal was to package collaboration expertise so that non-collaboration experts such as learners could execute a designed work practice without training in tools and techniques. During HLL-experience, and thus the execution of the HLL-PSA, only one learner had technical problems while all others were able to follow the collaboration successfully and got access to all necessary information. Each of the 16 breakout groups submitted a group-deliverable in the form of a slide show solution for one subtask. During the collaborative activities there was rich communication and reciprocity among the learners. The learners asked each other questions and responded to the questions from other teammates. Furthermore, learners in the treatment sample were equally satisfied than the learners in the control sample who had to invent their own ad hoc collaboration process (see Table 71). However, on 'perceived team performance' I observed a significant ($p < 0.029$, two-tailed) difference between the treatment and control sample. Students in the treatment sample rated the 'perceived team performance' as more positive (Mean = 5.2319) than students in control sample (M = 4.7630). These results indicate that I was able to achieve my second design goal: i.e., to package collaboration expertise to allow learners to conduct my process by themselves successfully, and at the same time to achieve the desired effects formulated in design goal 1.

Q7: Did the use of HLL-PSA lead to a difference in the satisfaction (SP, SO, TOOLDIF, Effic, Effec, Prod, TP) by treatment?						
	Treatment		**Control**		**t(df) = t-value**	**p-value**
	N	**Mean**	**N**	**Mean**		**(2-tailed)**
SP	47	4.5390	52	4.7308	t(97) = 0.668	0.506
SO	47	4.8628	49	5.1316	t(94) = 1.031	0.305
TOOLDIF	47	3.4734	49	3.4745	t(94) = 0.008	0.994
Effic	47	4.9901	51	5.1739	t(96) = 0.852	0.396
Effec	47	4.8613	48	5.1128	t(93) = 1.158	0.250
Prod	46	4.9967	50	5.1420	t(94) = 0.706	0.482
TP	46	5.2319	45	4.7630	t(89) = 2.225	0.029*
*Mean difference significant at the level *p<0.05, **p<0.01*						

Table 71: Differences in Satisfaction by Treatment
Source: own illustration

6.3.11 Discussion

In this section, I discuss the findings from my study and formal validation. In the discussion of the findings I refer to the two design goals of the study.

6.3.11.1 Design Goal 1 - Enhancing HLL in Large University Classes

My study comprised actual performance measures of LLL from pre- and post-tests as well as actual performance measures of LLL and HLL from lecturer assessments to explore whether the HLL-CP meets the design goal. Table 72 outlines a brief summary of the results in relation to the hypothesis and exploratory research questions explaining whether HLL-PSA enhances HLL among learners. In the following discussion, I outline possible explanations for the resulting effects.

Hypothesis 1		
H_1	**	$H_1$is supported. On the 'HLL-LevelSophistication', students in the treatment sample (Mean = 5.425) performed significantly better than those in the control sample (Mean =3.825).
Overall LLL effects		
Q_1	**	All students performed significantly better on the four '*pre-and-post-questions*' in the post-test (Mean = 0.5644) than in the pre-test (Mean = 0.5099).
Q_2	*	In the post-test, all students performed significantly differently on the *'pre-and-post-questions'* (Mean = 0.5644) vs. '*post-only-questions'* (Mean = 0.6757).
Differences in LLL by treatment		
Q_3	*	On the '*8-LLL-questions*' of the post-test, students in the treatment sample (Mean =0.6622) performed significantly better compared to students in the control sample (Mean = 0.5841).
Q_4	ns	On the '*pre-and-post-questions*' of the post-test, there is no significant difference in students' performance scores by treatment (treatment sample – Mean = 0.6064 │control sample – Mean = 0.5337).
Q_5	**	On the '*post-only-questions*' of the post-test, students in the treatment sample (Mean = 0.7181) performed significantly better compared to students in the control sample (Mean = 0.6346).
Q_6	ns	On the '*LLL level of correctness*' measured by the lecturer assessment, there is no significant difference in students' performance by treatment (treatment sample – Mean = 5.625 │control sample – Mean = 5.525).
Differences in satisfaction by treatment		
Q_7	ns	Students in the treatment sample are as equally satisfied as students in the control sample in terms of '*SP, SO, TOOLDIF, Effic, Effec, Prod'*.
	*	Students in the treatment sample rated the *'perceived team performance'* significantly more positively (Mean = 5.2319) than students in the control sample (M = 4.7630).
*Mean difference significant at the level *p < 0.05, **p < 0.01, ns = not significant*		

Table 72: **Overview of the Results for Analyzing Effects of LLL and HLL**
Source: own illustration

The results showed significantly more HLL among students in the treatment sample, i.e., those who followed the engineered HLL-PSA. Their work products had a higher-level of sophistication than those of learners in the control sample who conducted an unstructured collaboration. Learners in the treatment sample demonstrated a high level of mastery which can only be achieved where one has first understood a set of more basic knowledge. The intention of HLL-PSA is to generate a common understanding of domain knowledge with the brainstorming activity (step 3). This way, the less expert learners have the chance to assemble more basic domain knowledge by reading the contributions from more expert learners. This may help the less expert learners to better build relationships among knowledge chunks in their working memory. Another explanation for this effect can be found by considering insights from Cognitive Load Theory (Sweller 1994). Students in the treatment sample were guided through collaborative activities and were able to focus primarily on the task. In contrast, students in the control sample had to spend part of their time inventing collaborative activities on their own. Consequently, students in the treatment sample gained more exposure to the learning content, and thus achieved faster discussions and contributions for representing a high-level of sophistication among domain knowledge. The LLL performance measures from the exploratory questions helped to explain the effect.

Since both samples had the same conditions, except the way of collaboration (see Table 64), I could analyze whether there was a domain knowledge increase in LLL performance. An increase in LLL performance indicates that collaboration supports learners in improving their expertise. Regardless of treatment, there was an increase in the individual LLL performance on the ‘pre-and-post-questions’ in the post-test (Q1). When the learners started the HLL-experience, the pre-test performance on the ‘pre-and-post-questions’ showed that the whole sample of learners is composed of approximate half top learners and half bottom learners. Since the top learners already had a good performance in the pre-test and the bottom learners had more room for improvement, this might be an indicator that the performance increase in the post-test can be attributed to the bottom learners. There might also be a priming effect, because the learners had already seen the questions in the pre-test. Against that background, it is interesting to note, that regardless of treatment, learners performed on the ‘post-only-questions’ statistically significant better than on the ‘pre-and-post-questions’ in the post-test (Q2). Overall, the learners benefited from the collaboration with each other. The collaboration among the learners may have helped them to improve their ability to apply their domain knowledge in answering the new questions.

Since the effects in LLL performance might also be affected by the way the learners collaborated with each other, I further analyzed whether there were differences between the two samples. In this context, I observed a significant effect on LLL by treatment on the ‘8-LLL-questions’ and on the ‘post-only-questions’. Students in the treatment sample (following engineered collaboration) performed better than students in the control sample (doing ad hoc collaboration). This supports my assumption that structured collaboration helped the students to juxtapose concepts and relationships in working memory. Students in the control group may have been distracted by having to invent ad hoc collaboration, which may have led to difficulties focusing on the task and discussing, understanding and processing the domain knowledge. This result is contrary to extant learning literature which argues that learner interaction should be ad hoc (Bodner 1986; Poplin 1988; Jones/Brader-Araje 2002) and should not be restricted by processes (Dillenbourg 2002). However, my result is also supported by CE literature, which argues that process restrictions can increase the number, quality, and creativity of ideas under certain conditions (Briggs et al. 2013). In my study, the use of HLL-PSA with its restrictions in learner behavior did not impede group performance, but rather helped the learners to perform better. It is important to note, however, that in practice, process restrictiveness is neither a panacea nor poison.

Restrictiveness creates value when it does the following: limits participants to useful behaviors; restricts them from ineffective behaviors; and affords sufficient flexibility to accommodate the conditions that typically emerge during execution of the work practice it supports. Process restrictions would not be useful if they restricted participants from actions they wanted to take regardless of whether the desired actions are productive (Briggs et al. 2013). Thus, part of the design challenge was to restrict learners to experience HLL effects but also to convince them that it is in their interest to avoid proscribed actions. My results indicate that I was able to master this part of the design challenge, since my process restrictions allowed the learners to perform better instead of hindering their progress.

Since PL is grounded on insights from constructivist learning theories, students must have the chance to learn by experiencing their environment. The HLL-PSA guides the learners through effective collaborative activities and reduces distractions; it takes over grouping challenges and provides step-by-step instructions to systematically collaborate with each other to solve a complex real-world problem. However, it provides flexibility and motivates learners by allowing them to take the actions they want for creating a solution collaboratively. The learners' high satisfaction responses show that they perceived the collaboration as valuable. The yield shift theory of satisfaction proposes that satisfaction responses are not a function of goal attainment but, rather, of the shift in the utility one ascribes to attaining a goal (Briggs/Reinig/de Vreede 2008). Amongst that background, I observed associations with the construct 'tool difficulty' (TOOLDIF, Mean = 3.47) that showed that following the collaborative actions was of average difficulty and did not cause much cognitive load. Furthermore, out of all registered participants, there was only one learner who had technical problems and was not able to participate. With respect to the total amount of participants, that is less than 1%. I also observed strong satisfaction both with the process and the outcome. The learners gained a positive satisfaction with the process (SP, Mean = 4.54) itself as well as with their group deliverable in the form of the solution (SO, Mean = 4.87). Furthermore, I observed a strong association of satisfaction with effectivity (Mean = 4.86), efficiency (Mean = 4.99), and productivity (Mean = 4.99) of the HLL-CP. These results show that the learners were motivated and had the chance to take desired actions for creating the group deliverable. Thus, the way in which the collaboration was structured in the treatment sample (engineered HLL-PSA) may predict the better performance. There was a rich collaboration among the learners which guided them to sophisticated collaborative activities. Taking all the findings together, I can conclude that I was able to achieve my first design goal, since students in the treatment sample did score better in the tasks related to HLL. Furthermore, my results also indicate positive effects on the LLL knowledge of learners in the treatment group.

6.3.11.2 Design Goal 2 - Packaging Sufficient Collaboration Expertise

The study derived GR for enhancing HLL in large classes. Those were derived from the body of PL literature and identifying the set unsolved problems for enhancing HLL in large classes. A requirement-based evaluation showed that the HLL Processes meets all GR (Table 63). From a formal point of view, this indicated that the HLL Process packages sufficient collaboration expertise to enhance HLL.

However, this does not necessarily mean that learners can or will follow a well-designed work practice and conduct the intended collaborative activities. Thus, my study comprised actual satisfaction measures to explore whether the HLL-PSA meets the design goal. The satisfaction levels are comparable in both samples. This indicates that learners were satisfied with the collaboration and thus, were able to follow and conduct the intended collaborative activities. The only significant difference I observed was in perceived team performance. Here, learners in the treatment sample perceived the team performance to be higher compared to learners in the control group. This further indicates that I achieved my second design goal, since the learners not only performed better objectively, but also perceived that their team delivered a good performance. Together with the fact that all breakout groups in the treatment sample were able to generate the requested deliverable, and were also able to achieve the desired result (i.e., more HLL), I can conclude that the learners were able to successfully conduct the HLL-

PSA by themselves without the need of external advice (e.g., by a lecturer or moderator). This indicates that I achieved my second design goal.

6.3.12 Contribution, Limitations and Future Research

Table 73 illustrates the knowledge contributions from a DSR point of view. I position my HLL design theory and its knowledge contributions in relation to the components of a design theory.

Component	Description (Gregor/Jones 2007)	Knowledge Contributions of my HLL Design Theory
Purpose and scope	"What the system is for," the set of meta-requirements or goals that specifies the type of artifact to which the theory applies and in conjunction also defines the scope, or boundaries, of the theory.	Students in conventional large classes do not gain as much HLL expertise as students in small classes. *The design goal of the study is to increase the HLL expertise students gain in large classes*.
Constructs	Representations of the entities of interest in the theory.	I provide a new definition of '*expertise'* as indicator for classifying students' domain knowledge with reference to HLL.
Principle of form and function	The abstract "blueprint" or architecture that describes an IS artifact, either product or method/intervention.	I develop an *HLL Process* as a generalizable solution for HLL experience in large classes. The design provides guidelines for solving a complex real world problem within distributed teams.
Principles of implementation	The description of procedures to implement the generalizable solution in specific contexts.	I develop the *HLL Methodology* as a procedure to build PSA from the HLL Process. The HLL Methodology helps lecturers to build their own exemplar instances of the HLL Processe.
Expository instantiation	A physical implementation of the artifact that can assist in representing the theory both as an expository device and for purposes of testing.	The *HLL-PSA* is used in a large class using Moodle and Google Docs. I conduct an online quasi experiment with two treatments for analyzing effects.
Testable propositions	Truth statements about the design theory.	Learners that participate in the HLL-PSA will perform better in HLL-related tasks compared to learners that participate in unstructured collaboration. Learners are able to complete the HLL-PSA, and achieve the desired results in terms of HLL performance, without the need of any further guidance by a lecturer or moderator.
Justificatory knowledge	The underlying knowledge or theory from the natural or social or design sciences that gives a basis and explanation for the design.	To guide my design choices I draw on pedagogical, PL literature, Cognitive Psychology literature, as well as insights from CE.

Table 73: Knowledge Contributions in the Context of the HLL Design Theory
Source: own illustration based on Gregor and Jones (2007)

Nevertheless, this study is not without limitations, which also provide opportunities for future research.

First, the validation of my HLL-PSA is founded on a HLL experience in a large class with undergraduate business students. Participants of the study were volunteers, who had the chance to gain up to four bonus points for their final exam. This incentive, however, may have the potential for self-selection bias. It may have excluded top-students who didn't want to bother with the HLL experience because they assumed they could learn the material on their own. It's also possible that it attracted only highly motivated students who want every opportunity to increase their course grade. However, I did not find evidence of such bias in this case; the proportion of high-expertise learners to low-expertise learners was similar among those who participated and those who did not. Nonetheless, this concern should be explored among other students in other settings.

Second, I report on a quasi-experimental setting in which the assignment of students to groups could not be completely random because the HLL-PSA required that each group be a mix of high-expertise and low-expertise learners. I therefore stratified the sample by expertise, and randomly assigned a set number of students from each stratum to each group. However, groups in both samples did start with equivalent distributions of domain knowledge (Table 67). Nonetheless, it would also be useful to test HLL-PSA under conditions where fully random assignment is possible.

Third, the validation of my HLL-PSA focuses on one exemplar instance, one case, one knowledge domain, one course, and one level of students (undergraduates). To further demonstrate the generalizability of the HLL Processes, and to discover and fix as-yet undiscovered limitations, future studies of the same HLL-PSA should be conducted with different tasks, different knowledge domains, and participants other than student populations.

Fourth, the goal of the validation was not to explore whether structured collaboration is a better learning strategy than ad hoc collaboration or individual learning. Nor did it explore whether some learners show comparable or better improvements of HLL by developing a solution alone. Rather, the goal was to demonstrate that the HLL-PSA has the potential to enhance HLL in large classes and, to show that carefully considered process restrictions could enable learners to successfully execute a well-designed work-practice without training in tools or techniques. The intention of the validation also was to show that restrictions in learner behavior do not block HLL and in fact, under some conditions, process restrictions could enhance HLL. Having achieved these goals, it would now be valuable for future research to pursue several follow-on questions:

- Under what conditions would systematically designed PL activities produce better results than other strategies?
- Under what conditions would ad hoc PL produce better results?
- Under what conditions would individual learning produce better results?

Fifth, my HLL-PSA focused on solving subtasks from a case to enhance HLL. Cases are an important, but not the only opportunity, to train HLL. Future research should focus on other tasks and group deliverables to enhance HLL and to create other methodologies similar to HLL-PSA. This may enlarge the application domain of CE in systematically designing solutions for HLL.

Sixth, in this study I developed the HLL Methodology that helps lecturers to build their own exemplar instances of the HLL Process in the form of a HLL-PSA. The focus of the current study was not to validate the application of the HLL Methodology by different lecturers. Thus, the scope of the HLL Methodology limited by the design choices derived from theory and practice. For future research it might be interesting to evaluate the application of the HLL Methodology by different lecturers and examine the quality of the developed HLL-PSAs.

6.3.13 Conclusion

This study addresses the set of unsolved problems of enhancing HLL in large classes by developing a HLL design theory that comprises the HLL Process, the HLL Methodology and the HLL-PSA. To answer the research question of how to enhance HLL in large classes with varying degrees of domain knowledge, I derived two design goals for my study (1) Enhancing HLL in large classes; (2) Packaging sufficient collaboration expertise and thereby empowering learners to conduct a well-designed work practice without extra guidance from a lecturer or moderator.

In the course of a quasi online experiment with 104 undergraduate business students, I instantiated the HLL Process and evaluated its HLL-PSA. Students had to solve a complex task from a case and report it on five slides. Students in the treatment sample followed an engineered HLL-PSA, whereas students in the control sample invented ad hoc collaborative activities. The results show that learners in the treatment sample significantly outperformed learners in the control sample in terms of HLL performance. My study also demonstrates how to package sufficient collaboration expertise so that non-collaboration experts (learners) can execute a well-designed work practice without training in techniques and expertise.

In summary, my study has contributed to DSR knowledge in several ways. *First*, I developed the construct ‘expertise’ to classify domain knowledge. *Second*, I provided principles of form and function in terms of ‘generalizable requirements for enhancing HLL in large classes’ and ‘HLL Process’ as generalizable solution. *Third*, I described principles of implementation by developing the HLL Methodology that helps lecturers to instantiate HLL Processes and thus, to build their own exemplar instances. *Fourth*, I provided an exemplar instance of my solution inherent in a ‘HLL-PSA’. I run the HLL-PSA with resources that are commonly available in universities: a learning management system (Moodle) and a shared document editor (Google Docs/ Slides). The approach can be supported, however, by any other technologies that afford the requisite capabilities. *Fifth*, my study contributes to justificatory knowledge in two topics: PL, since it shows that engineered collaboration with its process restrictions can support HLL; and CE, since it provides insights for a new application domain of engineering learning practices.

7 LIMITATIONS AND SCOPE OF THE THESIS

To summarize the limitations and scope of the thesis and, more precisely, those of the different studies, I refer in the following to aspects that might bias the results and thus, limit the generalizability of the results. In a first step, I refer to quality criteria of empirical research in general. In a second step, I refer to the limitations in the context of the different studies of the thesis. Based on this, I finally summarize the scope of the results of the thesis.

A research design that focuses on evaluations in the field with real stakeholders might be biased. A bias can for example result from other conditions that influence the behavior of the participants in a study, or the population of the sample might not be representative for the aim of the study. To find out whether there is a bias in the empirical results of a study, an understanding of the quality criteria of empirical research is vital. The results of a study will have a representative character in terms of meeting the quality criteria. These quality criteria are validity, reliability, and objectivity:

- *Validity* refers to adequacy, meaning that the measures are adequate to examine the intended research questions. It refers to the rigor that is applied to the data collection (Stangl 2006b; Trochim 2006).

- *Reliability* refers to the trustworthiness of an evaluation. It represents the consistency or repeatability of the measures used in the study (Trochim 2006). More precisely, it refers to the question whether further evaluations under the same conditions will lead to comparable results and thus, indicate that the results are stable (Stangl 2006b; Trochim 2006).

- *Objectivity* refers to independency, meaning that the responses to interview questions or surveys are not influenced by the researcher. A study is objective in terms that the researcher does not influence the participants of the study in their responses (Stangl 2006b; Trochim 2006).

The thesis consists of five studies, each of them following a DSR approach (see chapters 4, 5, and 6). Consequently, the design choices are informed by the practical problem situation and the kernel theories that underlie the research. Moreover, all evaluations took place in the field with real stakeholders. From that point of view each of the studies might have a bias in terms of conditions in the field that did not result from the design artifacts itself. All evaluations took place with students from universities from Germany and Switzerland. Nevertheless, in each of the studies I controlled the conditions in order to prevent bias with regard to the results. In addition I looked for a possible bias in the results and did not find evidence for any. Even though, the studies are not without limitations. In order to refer to specific limitations, Table 74 summarizes the limitations of the different studies:

Study	Limitations
Flipped-Classroom Concept (see chapter 4)	The study of the Flipped-Classroom Concept aimed at gaining explorative insights into how to activate the learner in large classes and examine the conditions for PL in large classes. *Other pedagogical mechanisms next to the flipped classroom concept:* Working with students in the field includes various pedagogical mechanisms which make the identification of cause and effect relationships difficult. Therefore, increases in learner interaction and satisfaction might not be solely attributed to my design artifact of the Flipped-Classroom Concept. *No measures on expertise:* The focus of the study was not on measuring expertise increases. Thus, the results of the study are limited to qualitative data which aimed at gaining insights into interaction increases, satisfaction responses as well as into examining the conditions for PL in large classes. Nevertheless the Flipped-Classroom Concept is informed by kernel theories of PL and from a theory-driven point of view meets these demands.
Peer-Learning Reference-Process Approach (PL-RPA) (see chapter 5)	The PL-RPA is a conceptual design artifact that illustrates the conceptual foundations on how to design peer-learning reference processes. *Theory-informed development of the PL-RPA:* The development and design choices of the PL-RPA are informed by kernel theories from PL and CE. The evaluation of the PL-RPA in the field (e.g., the use of the PL-RPA by other designers to design reference processes for PL) was not a focus of the study and thus, not empirically evaluated. Therefore, the generalizability of the results of the PL-RPA is limited to the theory-informed conceptual design choices.

Peer-Learning Process Design (PL-PD) (see chapter 6.1)	The focus of this study was on designing innovative solutions and gaining first insights into the potential of reference processes for PL with regard to expertise increases. *Applicability of the PL-PD to company settings:* For the evaluation of the PL-PD I used pilot schemes in a university setting. Thus, students participated in the PL-PD and not employees from a company. Even though students are useful surrogates for knowledge workers. In my evaluation, practitioners (students) had a comparable expertise. Consequently, the generalizability of the PL-PD with regard to company settings is limited by this condition of the evaluation. *Transferability in terms of large class sizes:* Even though the main focus of the study was to gain first insights into whether reference processes for PL like the PL-PD have the potential to leverage the power of PL and whether the approach leads to expertise increases among the practitioners, I will briefly refer to transferability aspects. Students from a small master's course served as practitioners in the pilot schemes. Thus, the population of practitioners in the pilot schemes is small. Still, the usage of IT-supported tools provided first insights into the transferability of the PL-PD. Consequently, the generalizability of the results with regard to transferability is limited to the condition of conducting the same PL-PD with different tool support. Using IT-supported tools provides potentials for saclability to large classes and automatization of collaborative processes.
Peer-Learning Pattern Approach (PL-PA) (see chapter 6.2)	*Modularity of the PL-PA:* The evaluation of the PL-PA was communicated as a HLL experience. For that reason I built exemplary instances that bundled the PSP and the CTP. Consequently, learners followed a HLL experience in which they passed the PSP and then the CTP. Consequently the generalizability of the results refers to a learning experience that consists of both patterns. *Transferability in terms of large classes [Population (N)]:* Even though the main focus of the study was on examining the transferability with regard to conducting the PL-PA by different lecturers, I will briefly refer to its applicability to large class sizes. In total N = 36 learners participated in the pilot schemes of the PL-PA (four subgroups). Thus, the generalizability of transferability aspects refers to the conduction of the PL-PA by different lecturers. *Predictability (Briggs et al. 2006):* Although different lecturers conducted the same PL-PA with IT-tools and with paper-based tools, the scope of the PL-PA is limited to the learning task and content of the same master's course. Thus, the generalizability of the results is more or less limited to this case.

HLL Design Theory (see chapter 6.3)	*Online quasi experiment and randomization:* For the evaluation I examined a quasi-experimental setting in which the assignment of learners to groups could not be completely random because the HLL-PSA required that each group be a mix of high-expertise and low-expertise learners. I stratified the sample by expertise, and randomly assigned a set number of learners from each stratum to each group. *Predictability (Briggs et al. 2006):* The evaluation of my HLL Design Theory focuses on one exemplary instance in the form of the HLL-PSA. This represents one case, one knowledge domain, one course, and one level of learners (undergraduates). Thus, the generalizability of the results is limited to one case of learning task.

Table 74: Overview of the Limitations in the Studies
Source: own illustration

In general and in the light of the limitations of the studies, the scope of the thesis can be described as follows:

Validity: Each of the studies meets the validity demands with regard to the design goals and the research question of the study. The studies followed a DSR approach and meet the formal demands of DSR. Moreover, the choice of the data collection methods and measures was led by the research question and design goals. In order to ensure construct validity, I used for the surveys in terms of e.g. satisfaction measures established constructs.

Reliability: In general, reliability is given in the studies. A possible bias of the data collection and evaluation was reduced as far as possible in the field studies. For exemple, consistency and repeatability is existent for the studies of the PL-PD (see section 6.1) and of the PL-PA (see section 6.2). The same master course with same learning content but different master students served as basis for the evaluation. The design artifact was iteratively evaluated under similar conditions among several semesters.

Objectivity: In each of the studies I respected aspects of objectivity. To ensure anonymity as well as a matching between pre- and post-surveys, I asked the study participants to use an acronym. From that point of view I reduced the impact of dependency between my participants and me in the role of the researcher.

Applicability of results to company settings (students as surrogates for knowledge workers): Even though university students are representative surrogates for knowledge workers, there were no evaluations in companies. Thus the generalizability of the results with regard to company settings is limited by this condition.

Applicability of results to other cultural areas (Western culture area): Students from German and Swiss universities belong to the same cultural area. This population is representative for the Western culture area. In this context, the results presented in the studies are generalizable for the Western cultural areas. Thus, the generalizability of the results with regard to e.g. Asian cultural areas is limited by this condition.

8 SUMMARY OF CONTRIBUTIONS

In the previous section I outlined the limitations of the thesis and referred to the different studies. In order to refer to the scope of the thesis in more detail, I discuss in the following the contributions in general and with regard to the different studies.

8.1 Knowledge Contributions and the Three Sieves of Socrates

To start the discussion of contributions, it is interesting to examine the contributions of the thesis from a philosophical point of view by referring to the tree sieves of Socrates. The tree sieves of Socrates are truth, goodness, and usefulness. This way, I close the philosophical discussion from the beginning and I show how my thesis copes with those demands.

Truth: The underlying epistemological understanding of truth was described in section 3.1. The research described in this thesis is characterized by the positivist and interpretivist paradigm. Depending on the aim of the research questions and the evaluations, the research is applicable to one of the paradigms. The study of the Flipped-Classroom Concept (see section 4) is influenced by the interpretivist paradigm since the aim inter alia was to examine and explore the conditions for PL in large classes. Consequently the results underlie interpretations of qualitative data. The results from the studies of the reference processes for PL (see section 6) are influenced by the positivist paradigm. The reality of the university and learner context constituted the ultimative truth. The evaluations aimed at analyzing quantitative data in order to gain prescriptive knowledge. Besides that epistemological understanding, truth of my results is given because I actively conducted the research and respected formal and ethical aspects of science.

Goodness: To verify whether the results in this thesis cope with demands of goodness, it is important to refer to the quality criteria of empirical research. In section 7 I discussed the limitations of the thesis and inter alia referred to the quality criteria of reliability, validity, and objectivity. The discussion in section 7 helped to verify the scope and goodness of my results. Overall, goodness of the results of the thesis is given. The generalizability of the results inter alia arises from the existing limitations.

Usefulness: In section 1.1 I introduced the importance of leveraging the potential of PL and identified three main challenges (Challenge 1: Explore the application domain of peer learning and create conditions to support higher-level-learning in large classes;

Challenge 2: Develop an approach to systematically design reusable peer learning activities, that satisfies the demands from learning and collaboration literatures; Challenge 3: Explore the proof of value of reference processes for peer learning in the field. The usefulness of leveraging the potentials of PL in the context of my research arises from the increasing demands for knowledge workers in the digital age. In order to cope with those demands I identified three main challenges and specified the conditions under which reference processes for PL become useful – e.g. in terms of being predictive and transferable (see section 1.2). Against that background the results of the thesis cope with the demand of usefulness.

8.2 Contributions to the Knowledge Base of Peer Learning and Collaboration Engineering

The philosophical discussion of the contributions outlined the classification of the contributions in a broader scientific context. Nevertheless, in order to attribute the contributions to the knowledge base of PL and CE, a discussion of the contributions against the background of their knowledge domain is needed.

Overall, the thesis makes contributions to the body of knowledge of PL and CE literature. However, to start with this discussion, it is important to respect the DSR understanding of theory (see section 3.2.2) and knowledge contributions (see section 3.2.3). This understanding guides the attribution of the contributions to the body of knowledge and thus, completes the rigor cycle of DSR. In addition, this understanding guides the classification of contributions to the type of knowledge contribution in the form of prescriptive knowledge.

The outcomes of my DSR studies are contributions in the form of prescriptive knowledge. To classify the level of knowledge contributions with regard to solution and application domain maturity, I used the DSR knowledge contribution framework (see Table 11). Depending on the point of view, the contributions in my studies can be classified as an ‘exaptation’ or as an ‘improvement’ (see section 3.2.3). From a CE perspective, the reference processes for PL can be classified as ‘exaptation’. I used thinkLets from CE and enriched them with pedagogical guidance to design reference processes for PL. From a CE perspective this constitutes a new problem, since the application of CE in the domain of PL is new. From a PL perspective the contributions can be classified as ‘improvement’ since the reference processes for PL constitute a new solution to the known problem of enhancing PL in large classes. Reference processes for PL can leverage the potentials of PL. They enable a knowledge transfer among the involved participants and stimulate cognitive processes for achieving HLL effects. This leads me to the main contributions of the thesis that can be summarized as follows.

8.2.1 The Flipped-Classroom Concept

In chapter 4 I answer *RQ 1: "What are basic conditions for a teaching-learning concept that provides opportunities to leverage the power of peer learning in large classes? (Application domain)"*. I describe the Flipped-Classroom Concept and make a contribution in the form of *a theory for design and action*. The Flipped-Classroom Concept proposes a design for activating the learner as a generalizable solution. I describe its implementation in a large class setting as an exemplary instance and examine the conditions for PL in large classes. I contribute to the body of PL literature in several ways by addressing several components of a theory for design and action (Gregor 2006; Gregor/Jones 2007; Gregor/Hevner 2013):

Purpose and Scope: Traditional teaching-learning concepts for large classes often lack learner centricity and conditions to train HLL. The design goal of the study was to develop a Flipped-Classroom Concept for large classes that – (1) overcomes the lack of interaction; and (2) provides the conditions for implementing PL to allow training HLL.

Principle of form and function: I propose a blueprint for a blended learning large class flipped classroom to redesign large IS classes, recognizing the important role of peers. This blueprint is represented by the Flipped-Classroom Concept that serves as generalizable solution to provide conditions for PL for HLL in large classes. The blueprint comprises inter alia requirements, design principles, and the design of a flipped classroom.

Testable hypothesis: The underlying hypothesis of the study refers to a teaching-learning concept for large classes that activates the learner by overcoming the lack of interaction. Integrating PL will allow training all levels of educational objectives compared to traditional teaching-learning concepts for large classes that mainly refer to the lower levels of educational objectives.

Expository instantiation: In this study I present a prototype of the Flipped-Classroom Concept that was implemented in a large class by using Moodle.

Overall, the study redesigns the IS classroom using a learner-centered approach to enable transfer of knowledge within several interaction sequences, from factual to metacognitive knowledge. The study helps to enable all educational objectives in a way that lecturers receive insights into how to design and conduct an exemplary instance of the Flipped-Classroom Concept and learners into how to follow learning activities of the Flipped-Classroom Concept. Moreover, the study contributes to the body of PL literature since it creates conditions for integrating constructivist driven PL activities into large classes. However, the results show that learners seem to be overstrained in their PL activities and demand more guidance in phase 2. These results indicate that the traditional form of constructivist-driven PL – by which learners are not restricted in their learning experiences – comes to its constraints. From that point of view the study opens the set of unsolved problems inherent in systematically designing PL activities in order to enable knowledge transfer stimulating cognitive processes for achieving HLL effects.

8.2.2 The Peer-Learning Reference-Process Approach

In chapter 5 I answer *RQ 2: "What are conceptual foundations and assumptions to systematically design reference processes for peer learning? (conceptual foundations)"* I describe the Peer-Learning Reference-Process Approach (PL-RPA) and make a contribution in the form of a *theory for design and action*. The PL-RPA describes the conceptual foundations to design reference processes for PL. It illustrates a theory-driven and conceptual study that outlines the research assumptions and classes of requirements that need to be addressed in order to design reference processes for PL. I contribute to the body of CE and PL literature in several ways by addressing several components of a theory for design and action (Gregor 2006; Gregor/Jones 2007; Gregor/Hevner 2013):

Purpose and scope: I contribute to the body of CE literature in terms of opening a new application domain. I describe the foundations to apply CE in the domain of PL by deriving research assumptions, requirements, and the PL-RPA. The design goal of the study was to develop an approach that creates an understanding to systematically designing replicable PL activities in order to enhance knowledge transfer stimulating cognitive for achieving learning effects. To gain insights and to develop the PL-RPA, I focused on knowledge documentation in the form of documenting the knowledge for high-quality learning material. This demands pedagogical underpinnings with regard to the learning task, a sophisticated understanding of knowledge, and thus refers to the upper levels of Bloom's revised taxonomy, and finally supports achieving HLL. Against that background the PL-RPA constitutes a contribution of the type 'improvement' (Gregor/Hevner 2013). The study provides the conceptual basics and starting point for systematically designing reference processes PL.

Principle of form and function: In this study, I generate prescriptive knowledge in the form of a *model*. This model comprises the research propositions for reference processes for PL (see Figure 17) and thus, the foundations to apply CE to the domain of PL. I generate prescriptive knowledge in the form of a *method (technique)* that is represented by the PL-RPA (see Figure 19). This provides guidance for designing reference processes for PL and illustrates the classes of requirements that need to be respected.

8.2.3 Reference Process (I) – Peer-Learning Process Design

In chapter 6.1 I answer *RQ 3a: "What are characteristics of a peer-learning reference process for transfer and documentation of knowledge that can be used regardless of tool support and that helps learners to expand their knowledge base"?* I develop the Peer-Learning Process Design (PL-PD), review qualitative and quantitative data from several iterative evaluations, and make a contribution in the form of a *nascent design theory*. I contribute to the body of CE and PL literature in several ways by addressing several components of a nascent design theory (Gregor 2006; Gregor/Jones 2007; Gregor/Hevner 2013):

Purpose and scope: In the study presented in chapter 6.1 I aimed to develop a PL-PD which promotes knowledge transfer and documentation with respect to how to conduct the PL-PD with different tool support (offline vs. online). I identified the lack of solutions for systematic knowledge transfer and documentation. Therefore the design goals of the study were DG 1 – to leverage the power of collaborative knowledge transfer and; DG 2 – to package sufficient collaboration expertise in the design of the PL-PD so that it can be executed with and without IT tool support.

Principles of form and function: I present generalizable requirements for designing collaborative processes to stimulate knowledge transfer; and the design of PL-PD as a generalizable solution.

Overall, I showed that PL activities can be designed in a reusable way by structuring learning activities and assignments. These designed PL activities have the potential to increase learners' expertise and help lecturers cope with transferability demands in terms of using IT-supported tools. This provides first insights into the general effectivity of designing PL activities in a structured and reusable way. This is contrary to the common understanding of the constructivist learning notion that argues that restricting learners in their learning experience will not lead to the intended learning results.

8.2.4 Reference Process (II) – Peer-Learning Pattern Approach

In chapter 6.2 I answer *RQ 3b: "How can peer-learning knowledge be packaged in a reusable design so that it comprises sufficient collaboration techniques to empower lecturers (and learners) to conduct (and follow) HLL activities in the classroom"?* I develop the Peer-Learning Pattern Approach (PL-PA) and make contributions along several components of a *design theory*. I used a mixed methods approach to iteratively gain insights. I contribute to the body of CE and PL literature in several ways by addressing several components of a design theory (Gregor 2006; Gregor/Jones 2007; Gregor/Hevner 2013):

Purpose and scope: Lecturers lack validated out-off-the-box techniques to initiate PL in the classroom in a reusable manner. At the same time, learners often feel overstrained with open-ended learning assignments in order to achieve HLL effects. The aim of the PL-PA is to package sufficient collaboration expertise to conduct PL activities for HLL. Therefore the design goals of the PL-PA are DG 1 – to help lecturers enhance PL activities for HLL in the areas of problem-solving and critical thinking in classes in a predictive way; DG 2 – to help learners proceed through PL activities with assisting guidance on collaboration.

Principle of form and function: I describe prescriptive knowledge in the form of *generalizable requirements* to empower lecturers to enhance PL activities. Besides that I present the *PL-PA design* with its two patterns as a generalizable solution. The design provides guidelines for lecturers to stimulate PL activities among learners in order to activate cognitive processes for achieving HLL effects.

Principles of implementation: To conduct the PL-PA with its two patterns I describe in the study principles of implementations that are visible in a description on how a lecturer has to establish general conditions (see Table 43). This description helps lecturers build their own exemplary instances of a PL-PA.

Testable hypothesis: To gain insights into my design goals of the study, I built several treatments in the evaluation setting (see Figure 28). To analyze the data I used hypothesis with exploratory questions to investigate findings toward the design goals of the study: H1 – The PL-PA conducted by the designer results in high learner satisfaction; H2 – Lecturers are able to conduct the PL-PA as good as the designer of the PL-PA, so that learners are equally satisfied regardless of the moderator; H3 – The conduction of the PL-PA with different tool support leads to comparable scores of perceived satisfaction by the learners.

Expository instantiation: I built several exemplary instances to evaluate and conduct the PL-PA with paper-based and with IT-supported tools. I constructed the PL-PA as an approach that helps lecturers to leverage the power of HLL in the disciplines of problem-solving and critical thinking.

Justificatory knowledge: I ground my research on PL and CE literature, and thus, postulate the potential of the PL-PA for enhancing HLL. The results show that principles from the body of CE literature can be applied to the field of PL in a way that process restrictions have the potential to support learners in their HLL experience. The results provide insights into the design of reference processes for PL activities that package sufficient collaboration expertise to empower lecturers to conduct those activities in a predictive way and provide learners with guidance that helps them cope with open-ended HLL tasks. The results show that different lecturers are able to conduct the PL-PA and achieve comparable results among learners.

Overall, the PL-PA resembles a 'theory of design and action' (Gregor 2006) of the contribution type 'improvement' (Gregor/Hevner 2013). The PL-PA with its two design goals focuses on empowering lecturers to enhance PL activities. The PL-PA with both patterns that provide reference processes for PL activities can be classified as a new solution. I respected generalizable requirements of PL and the problem domain in my design choices. Furthermore, I described the conditions that lecturers have to deal with in order to conduct the PL-PA.

8.2.5 Reference Process (III) – HLL Design Theory

In chapter 6.3 I answer *RQ 3c: "How can one enhance higher-level learning in large classes among students"?* I develop the HLL Design Theory and make a contribution in the form of a *design theory*. I contribute to the body of CE and PL literature in several ways by addressing several components of a design theory (Gregor 2006; Gregor/Jones 2007; Gregor/Hevner 2013):

Purpose and scope: In conventional large classes students do not gain as much HLL expertise as students in small classes. Therefore, the design goal of the study is to increase the HLL expertise students gain in large classes. Thus, I aim to gain insights into the two design goals: DG 1 – to enhance HLL for large class contexts; DG 2 – to package sufficient collaboration expertise in the process design so that non-experts (learners) can execute a well-designed work practice without training in tools or techniques.

Constructs: To classify increases in students' domain knowledge with regard to HLL effects, I provide a new definition of the construct 'expertise'.

Principle of form and function: I describe prescriptive knowledge in the form of *generalizable requirements* for enhancing HLL in large classes and in the form of the *HLL Process* as a generalizable solution for enhancing HLL experiences in large classes. The design provides guidelines for solving a complex real-world problem within distributed teams.

Principles of implementation: I developed the *HLL Methodology* as a procedure to build PSA from the HLL Process. Like the HLL Process this also constitutes prescriptive knowledge. The HLL Methodology helps lecturers to build their own exemplary instances of HLL Processes.

Expository instantiation: By using the HLL Methodology to build an exemplary instance of the HLL Process I developed and described the *HLL-PSA* as the fourth type of prescriptive knowledge in that study. The HLL-PSA was used in a large class using Moodle and Google Docs. I conducted an online quasi experiment with two treatments to analyze effects of the potential of the HLL-PSA to increase learners' expertise.

Testable hypothesis: To verify increases in learners' expertise I hypothesized that learners who participate in the HLL-PSA will perform better in HLL-related tasks compared to learners that participate in unstructured collaboration not following the HLL-PSA. My results show that learners are able to complete the HLL-PSA, and achieve the desired results in terms of HLL performance without the need of any further guidance by a lecturer or moderator.

Overall, the study presents a holistic DSR project that reports the design and a broad evaluation of HLL effects.

8.3 Contributions to Practice

All studies in this thesis present DSR projects. Consequently, each chapter is structured as a holistic study outlining a specific aim and answering research questions. This structure helps practitioners to find entry points for using the results for their demands in practice. The description of clear design goals; a detailed overview of the designs of each of the design artifacts; and the evaluations that examine the results as well as the discussion of limitations with the scope of the findings; help practitioners find anchor points for using the results on their own.

The results are aimed at practitioners, mainly lecturers and managers from industry, who are involved in developing knowledge management initiatives or human resource development. Leveraging the potentials of PL by having reference processes helps to qualify knowledge workers. On the one hand it is highly relevant for universities in order to provide high-quality education. The results presented in this thesis provide insights for enhancing PL activities that enable cognitive processes for achieving HLL effects. The learners receive a sophisticated understanding of knowledge concepts and their relationships. On the other hand, approaches like reference processes for PL are highly relevant for improving knowledge management initiatives in companies. Those insights help companies to enable knowledge transfer among their employees in a reusable manner as well as to retain the valuable knowledge from their knowledge workers.

The *Flipped-Classroom Concept* provides practitioners with insights into how to design a teaching-learning concept for large classes that overcomes the lack of interaction. Therefore, the results are highly relevant for practitioners who have to face learners' low persistence and high drop-out rates, which is the case in traditional large-scale university lectures (Garavan et al. 2010b; Jordan 2014). Moreover, the results provide practitioners with insights into the conditions for PL in large classes.

The *Peer-Learning Reference-Process Approach (PL-RPA)* gives practitioners a method that helps them design reference processes for PL. More precisely, practitioners receive guidance on important domains of requirements that need to be respected in order to develop reference processes for PL. This approach has the potential to make organizations like universities, and companies independent from external educators and standardize inexplicit pedagogical methods and routines.

The *Peer-Learning Process Design (PL-PD)* examines the effectivity of reference processes for PL with regard to tool support. On the one hand, practitioners receive a design for enhancing knowledge transfer and documentation among learners who collaboratively develop a storyboard for an explanation video. On the other hand, practitioners are supported in their decision of using different tool support to conduct PL-PD. The study develops the PL-PD in a way that a practitioner can build their own exemplary instance by using paper-based or IT-supported tools. The PL-PD is inter alia documented by an internal agenda that provides lecturers guidance in conducting the PL-PD.

The *Peer-Learning Pattern Approach (PL-PA)* focuses on how to empower lecturers to conduct PL-PA. Practitioners receive two modular reference process designs – one focusing on training problem-solving abilities, the other focusing on training critical thinking abilities. Both are documented in the form of an internal agenda that can be used by practitioners. Moreover, practitioners receive a method that guides them through preparation activities in order to build an exemplary instance and thus to conduct the PL-PA.

The *HLL Design Theory* provides lecturers with a design for enhancing HLL in large classes. Lecturers can use the documentation of the HLL Process as design pattern that provides them insights to the specific PL activities. Using the HLL Methods helps them to build their own exemplary instance while the HLL-PSA provides them an example prototype that was instantiated in a large university class. Consequently, lecturers can build their own PSA by using the HLL Design Theory. Moreover, practitioners from industry can use the HLL Design Theory to enable knowledge transfer activities among theor employees.

However, with regard to future research and the application of the results to other domains – expect qualification of knowledge workers by initiating a knowledge transfer among learners – the audience of practitioners can be expanded. The results will also be of high relevance for practitioners in the domain of computer science, more precisely for those that deal with collaborative interactive learning (Calma et al. 2016; Bahle et al. 2017). The results will provide this audience with guidance on how to design information systems that allow collaborative activities with the aim a.) to help the system achieve knowledge gains; b.) to help the involved humans achieve knowledge gains by an interaction with the system.

9 DIRECTIONS FOR FUTURE RESEARCH

This chapter of the thesis outlines a brief research agenda. In order to derive future research directions it is important to refer to the following three questions: (1) What do we know? (2) What don't we know? (3) What are future research directions?

To answer the question *'what do we know?'* I described in chapter 7 the limitations of the thesis with regard to the different studies. This underpins the scope of the results presented in the studies. In chapter 8 I provided a summary and a discussion of the contributions of the thesis with regard to the studies.

To answer the question *'what don't we know?'* I summarized in chapter 7 the limitations of the studies. These limitations provide important directions for future research.

This leads me to the question *'what are future research directions?'* Figure 31 illustrates a research agenda that results from leveraging the potentials of peer learning. At the bottom, the figure refers to several application domains that result from this research. These are PL, CE, information science, and crowdsourcing. While the first ones were part of this thesis, the latter ones provide further research directions in other domains. On the left, the figure refers to research strategies and possible phenomena of interest to conduct DSR projects in the context of leveraging the power of PL research. On the right, the figure refers to a classification of the type of knowledge contributions that will result from DSR projects in that field of research. To discuss directions for future research I refer in the following to directions for future research that result from the application domain of PL and CE and thus, from the studies that I present in this thesis. Second, I broaden the perspective and briefly discuss future research directions in the fields of information science and crowdsourcing.

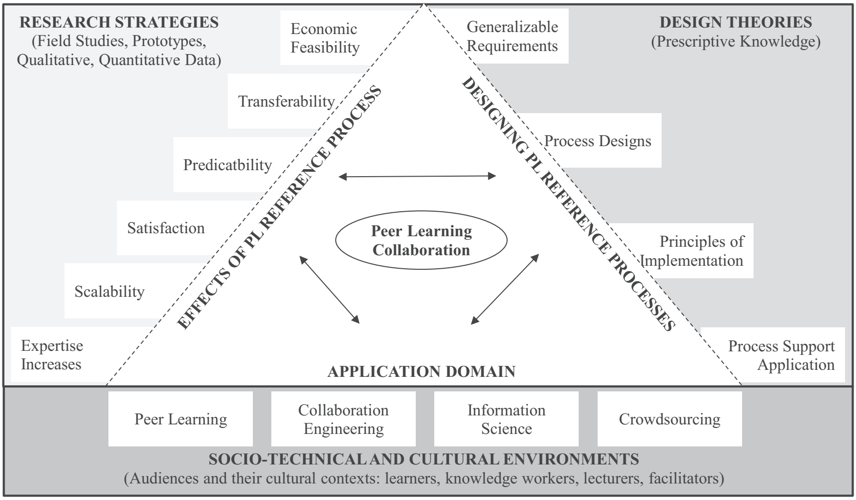


Figure 31: **Research Agenda**
Source: own illustration

At the end of the different studies of this thesis I already described directions for future research that result from the specific study. Some of the future research directions that I described in the chapters were already part of this thesis in the subsequent chapters. Nevertheless, there are some implications that should be addressed in future research. In the following I summarize those directions for future research:

- For the *Flipped-Classroom Concept* in chapter 4, future research should focus on developing and evaluating mechanisms to motivate the learners by using incentives. The population in the sample constituted undergraduate bachelor university students. Those students might need more motivational guidance to experience HLL than students on a master level. To motivate the learners and communicate an additional benefit that satisfies their individual goals, the Yield Shift Theory of Satisfaction (Briggs/Reinig/de Vreede 2008) might be a starting point for future research.

- For the *Peer-Learning Reference-Process Approach (PL-RPA)* future research should focus on the application and evaluation of the PL-RP in the field. The evaluation should focus on designers (e.g., lecturers, collaboration engineers) that use the PL-RPA to design reference processes for PL. The reference processes developed by the designers should be the focus of the evaluation with regard to its economic feasibility.

- For the *Peer-Learning Process Design (PL-PD)* future research should focus on an application and evaluation of PL-PD in an industry setting with employees. In that context the evaluation should verify the impact of PL-PDs on enhancing knowledge transfer and knowledge documentation among employees. A potential knowledge transfer to third parties that results from the knowledge documentations should also be part of future research. In that context, the collaborative outcome in the form of knowledge documents should be the focus of such an evaluation.

- For the *Peer-Learning Pattern Approach (PL-PA)* future research should verify insights toward predictability and reusability (see section 2.2.6). Therefore, future research should focus on evaluating effects that result from (a) lecturers that build their own exemplary instance of a PL-PA; (b) conducting the same PL-PA design with a different learning task. Future research, therefore, should use the PL-PA with different tasks and different lecturers.

- For the *HLL Design Theory* future research should focus on analyzing the conditions under which systematically designed PL activities will produce better results than other learning strategies. Moreover, it might be interesting for future research to examine the conditions under which ad hoc PL produces better results than systematically designed PL.

The application domains of information science and crowdsourcing provide additional opportunities for future research: The research stream of collaborative interactive learning has some parallels in common with the research of this thesis. Collaborative interactive learning refers to humans (experts or non-experts) as well as smart systems that collaborate with each other to solve a problem and achieve expertise increases (Calma et al. 2016; Bahle et al. 2017). Future research directions should focus on situations, in which smart systems take over the role of a crowdsourcer (the intermediate that allocates tasks to crowdsourcees) (Calma et al. 2016; Bahle et al. 2017). In that context, it will be interesting to analyze the types of tasks that exist in the context of collaborative interactive learning (Calma et al. 2016; Bahle et al. 2017). From that point of view it is important to analyze demands for structuring complex tasks in order to allow automated processing by smart systems and humans (Calma et al. 2016; Bahle et al. 2017). The structuration of tasks provides potentials to be represented by a collaborative work practice. Mechanisms will become relevant that help smart systems to distribute and allocate a complex task to the crowdworkers who have the required knowledge to develop a solution for the problem (Calma et al. 2016; Bahle et al. 2017).

In that context, future research should focus on mechanisms that help compose a group of humans who should solve the task as well as the collaborative work practices between humans, and between humans and the system (Calma et al. 2016; Bahle et al. 2017). Consequently, matching of expertise becomes also relevant in order to compose high performing learning groups (Calma et al. 2016; Bahle et al. 2017).

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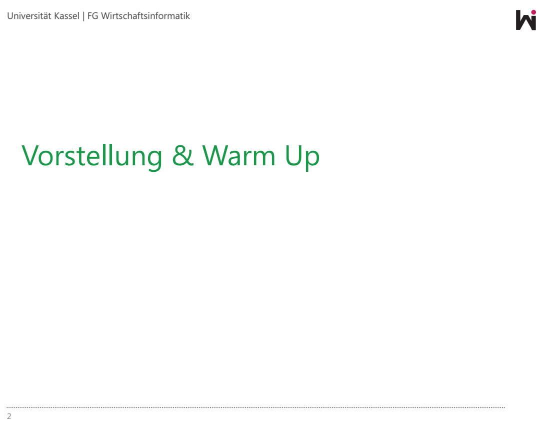
APPENDIX

Appendix A. Peer-Learning Process Design

Appendix 1 Moderation Slides of the Peer-Learning Process Design



Vorstellungsrunde

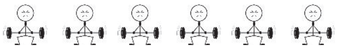
Moderation:

Name

Name

Teilnehmer
der Lehrveranstaltung
Collaboration Engineering

Warm Up



Wer hat....

... schon eLearning Material genutzt?

... schon Wissen dokumentiert und weitergegeben?

... schon Lern-materialien für andere erstellt?

Zielsetzung

Ziel des Kollaborationsworkshops

Vertiefung, Weitergabe und Dokumentation von Grundlagenwissen des Collaboration Engineering

in Form der Erstellung eines Drehbuchs für ein Erklärvideo „Kochrezept: Designentwicklung von Kollaborationsprozesse “

innerhalb der nächsten 6 Stunden.

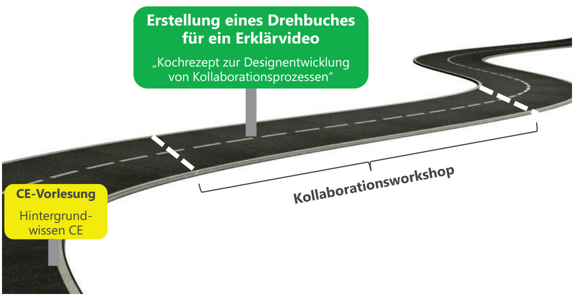
Ziel des Kollaborationsworkshops

Was Sie heute lernen werden…

Ihr Wissen über Collaboration Engineering in Bezug auf die folgenden Lernziele weitergeben und dokumentieren:

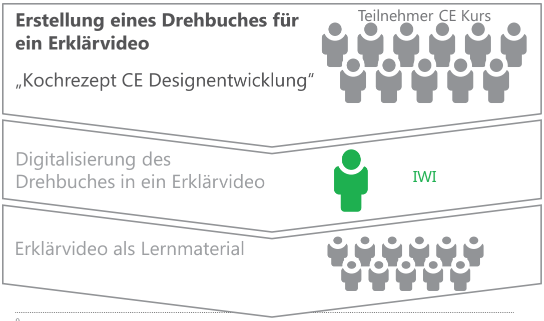
- Sie können Collaboration Engineering definieren und seine Bedeutung beschreiben.
- Sie können die Rollen im Collaboration Engineering unterscheiden und deren Bedeutung beschreiben.
- Sie können die wesentlichen Konzepte des Collaboration Engineering zur Designentwicklung beschreiben und anhand dessen die Vorgehensweise zur Designentwicklung erläutern.
- Sie können ein „allgemeines Kochrezept“ für die Designentwicklung beschreiben.

Ziel des Kollaborationsworkshops
→ Wo Sie sich befinden…



8

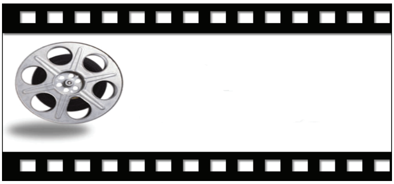
Ziel des Kollaborationsworkshops
→ Erwartetes Ergebnis…



9

Ziel des Kollaborationsworkshops
→ Was ist ein Erklärvideo?

- Besondere Form von Lernmaterial, das der Wissensvermittlung zum besseren Lernen dient.
- Komplexe Inhalte werden in kurzen und einfach verständlichen Geschichten erklärt.
- Beispiel:



10

Ziel des Kollaborationsworkshops
→ Was ist ein Drehbuch?

- Alle Inhalte für das Erklärvideo werden papierbasiert dokumentiert.
  - Geschichte unterteilt in einzelne Szenen
  - Skizzenhafte Visualisierung der Szenen
  - Einzusprechender Erklärungstext der Szene
  - Aufbau der Szenen (Beschreibung der Animation)
- Beispiel

11

Szene 1 -

Visualisierung für Video	Wörtlich einzusprechender Text	Informations-fluss
	Die Welt der Erklärvideos. In diesem Video wird Ihnen kurz und knapp gezeigt [...]	Start → Thema aufgezeigt

Ziele des Drehbuches (Erklärvideos)

- Sie können Collaboration Engineering definieren und dessen Bedeutung beschreiben.
- Sie können die Rollen im Collaboration Engineering unterscheiden und deren Bedeutung beschreiben.
- Sie können die wesentlichen Konzepte des Collaboration Engineering zur Designentwicklung beschreiben und anhand dessen die Vorgehensweise zur Designentwicklung erläutern.

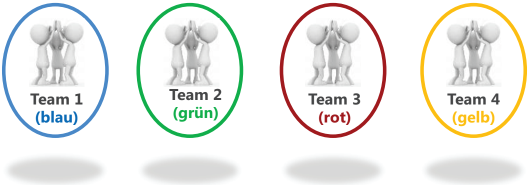
Ihre Aufgabe besteht darin,
ein Drehbuch zu erarbeiten, das eine Geschichte zur Erklärung "Kochrezept Designentwicklung Kollaborationsprozess" beschreibt!

D.h. Fachwissen zum Thema CE so aufbereiten, damit Lernmaterial (Drehbuch für Erklärvideo) entsteht, das diesen Anforderungen gerecht wird.

Gruppeneinteilung

Einteilung der Teams

Gruppeneinteilung durch Abzählen von 1-4



Grundlagen CE | Grobkonzept Drehbuch | Storyline Drehbuch | Feinkonzept Drehbuch | Qualitätsbewertung

Grundlagen Collaboration Engineering

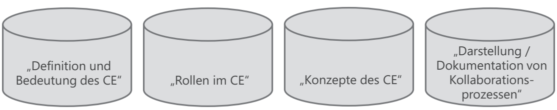
Gemeinsame Wissensbasis schaffen

Grundlagen CE | Grobkonzept Drehbuch | Storyline Drehbuch | Feinkonzept Drehbuch | Qualitätsbewertung

Arbeitsanweisung

Bitte reflektieren Sie Ihr Wissen über Collaboration Engineering anhand der vorgegebenen Kategorien.

Notieren Sie zu den jeweiligen Kategorien in aussagekräftigen Stichpunkten das Wissen, was Ihnen dazu einfällt.



Grundlagen CE | Grobkonzept Drehbuch | Storyline Drehbuch | Feinkonzept Drehbuch | Qualitäts-bewertung

Arbeitsanweisung

20

Bitte lesen Sie sich die Beiträge zu den einzelnen Kategorien durch. Fassen Sie die Beiträge zusammen, in dem Sie eine kurze und prägnante Zusammenfassung schreiben.

Definition/ Einordung des CE | Rollen im CE | Konzepte des CE | Darstellung von Kollaborationsprozessen

18

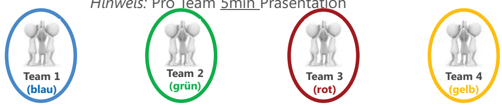
Grundlagen CE | Grobkonzept Drehbuch | Storyline Drehbuch | Feinkonzept Drehbuch | Qualitäts-bewertung

Arbeitsanweisung

25

Jedes Team präsentiert nun ihr Ergebnis.

Hinweis: Pro Team 5min Präsentation



Definition/ Einordung des CE | Rollen im CE | Konzepte des CE | Darstellung von Kollaborationsprozessen

19

Universität Kassel | FG Wirtschaftsinformatik

Grundlagen CE | **Grobkonzept Drehbuch** | Storyline Drehbuch | Feinkonzept Drehbuch | Qualitäts-bewertung

Grobkonzept für Drehbuch

Ideen sammeln und gemeinsame Leitidee entwickeln

20

Grundlagen CE | **Grobkonzept Drehbuch** | Storyline Drehbuch | Feinkonzept Drehbuch | Qualitätsbewertung

Arbeitsanweisung

Sammeln Sie einzeln Ideen für die Geschichte des Erklärvideos „Kochrezept Designentwicklung Kollaborationsprozess "!

Notieren Sie zu den jeweiligen Kategorien in aussagekräftigen Stichpunkten Ideen, die Ihnen einfallen.

- Kernbotschaft der Geschichte
- Aufbau/ Dramaturgie der Geschichte
- Collaboration Engineering Themen
- Anwendungsbeispiel und Designentwicklung

21

Grundlagen CE | **Grobkonzept Drehbuch** | Storyline Drehbuch | Feinkonzept Drehbuch | Qualitätsbewertung

Arbeitsanweisung

Finden Sie sich innerhalb Ihrer Teams ein!

- Team 1 (blau) → Kernbotschaft der Geschichte
- Team 2 (grün) → Aufbau/ Dramaturgie der Geschichte
- Team 3 (rot) → Collaboration Engineering Themen
- Team 4 (gelb) → Anwendungsbeispiel/ Designentwicklung

22

Grundlagen CE | **Grobkonzept Drehbuch** | Storyline Drehbuch | Feinkonzept Drehbuch | Qualitätsbewertung

Arbeitsanweisung

Diskutieren Sie innerhalb Ihres Teams die einzelnen Ideen der Ihnen zugeordneten Kategorie.

Sortieren Sie die Ideenliste, in dem Sie die Ideen den folgenden Containern zuweisen

KATEGORIE → Weiter zu verfolgende Ideen

KATEGORIE → Doppelte / nicht passende Ideen

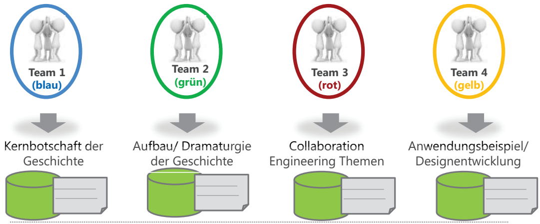
23

Grundlagen CE | **Grobkonzept Drehbuch** | Storyline Drehbuch | Feinkonzept Drehbuch | Qualitäts-bewertung

Arbeitsanweisung

20

Bitte schreiben Sie eine kurze und prägnante Zusammenfassung zu den weiter zu verfolgenden Ideen



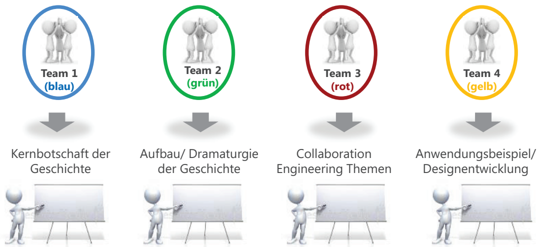
24

Grundlagen CE | **Grobkonzept Drehbuch** | Storyline Drehbuch | Feinkonzept Drehbuch | Qualitäts-bewertung

Arbeitsanweisung

25

Jede Gruppe präsentiert nun ihr Ergebnis.



25

Universität Kassel | FG Wirtschaftsinformatik

Grundlagen CE | Grobkonzept Drehbuch | **Storyline Drehbuch** | Feinkonzept Drehbuch | Qualitäts-bewertung

Storyline für Drehbuch

Einheitliche Szenenabfolge

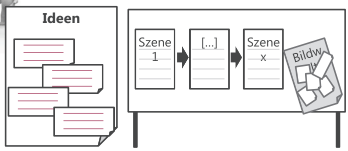
26

Arbeitsanweisung

Offene Diskussion aufbauend auf den generierten Ideen.

Leitfrage: „Was sind Schlüsselszenen?“

Moderator notiert Szenennamen



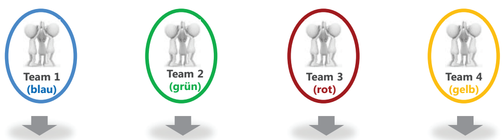
Feinkonzept für Drehbuch

Textuell beschriebene und visualisierte Szenen

Arbeitsanweisung

Bitte arbeiten Sie innerhalb der Gruppen die Ihnen zugewiesenen Szenen aus

- **Verwenden Sie die Papiervorlage, um Skizzen pro Szene anzufertigen.**
- **Verwenden Sie ebenfalls die Vorlage, um Erklärungstexte pro Szene anzufertigen.**



Szene Nr | Szene Nr | Szene Nr | Szene Nr

Grundlagen CE | Grobkonzept Drehbuch | Storyline Drehbuch | **Feinkonzept Drehbuch** | Qualitätsbewertung

Arbeitsanweisung

45

- Jedes Team präsentiert nun ihr Ergebnis!
- Zuhörer können jede Szene schriftlich kommentieren. Leitfragen:
  - Weist die Szene(n-abfolge) Inkonsistenzen auf?
  - Wie kann der Text besser formuliert werden?

Team 1 (blau) — Szene Nr. – Nr.

Team 2 (grün) — Szene Nr. – Nr.

Team 3 (rot) — Szene Nr. – Nr.

Team 4 (gelb) — Szene Nr. – Nr.

30

Grundlagen CE | Grobkonzept Drehbuch | Storyline Drehbuch | **Feinkonzept Drehbuch** | Qualitätsbewertung

20

Arbeitsanweisung

Diskutieren Sie innerhalb Ihres Teams die einzelnen Kommentare an den Szenen.

- Nehmen Sie die Kommentare auf und arbeiten Sie diese in die Erklärungstexte ein.
- Erstellen Sie zu jeder Szene ein Flussdiagramm, um den Aufbau der Szene zu strukturieren. Verwenden Sie dazu die Papiervorlage.

31

Grundlagen CE | Grobkonzept Drehbuch | Storyline Drehbuch | **Feinkonzept Drehbuch** | Qualitätsbewertung

Arbeitsanweisung

25

Jedes Team präsentiert nun ihr Ergebnis und geht dabei nur kurz auf die vorgenommenen Änderungen ein!

Team 1 (blau) — Szene Nr. – Nr.

Team 2 (grün) — Szene Nr. – Nr.

Team 3 (rot) — Szene Nr. – Nr.

Team 4 (gelb) — Szene Nr. – Nr.

32

Qualitätsbewertung

Qualität des Drehbuches sicherstellen

Grundlagen CE | Grobkonzept Drehbuch | Storyline Drehbuch | Feinkonzept Drehbuch | **Qualitäts-bewertung**

QUALITÄT DREHBUCH

	1 --- Äußersts chlecht	2 --	3 -	4 /	5 +	6 ++	7 +++ hervor-ragend
Lerninhalte vollständig							
Lerninhalte korrekt							
Vorgegebene Lernziele adressiert							
Potenzial zur Steigerung der Lernmotivation							
Art der Darstellung							

Appendix 2 Pre-Evaluation Measures

Liebe Studierende,

wir möchten Sie bitten, den folgenden Fragebogen auszufüllen. Ihre Angaben werden nur für wissenschaftliche Zwecke verwendet. Wir gehen streng vertraulich mit Ihren Angaben um.
Es gibt keine richtigen und falschen Antworten. Antworten Sie so, wie es für Sie persönlich zutrifft. Wir sind an Ihrer ehrlichen Meinung interessiert.

Damit wir Ihre Aussagen einander zuordnen können, tragen Sie bitte einen Code nach dem folgenden Schema ein:

1. Anfangsbuchstabe Vorname Mutter
2. Anfangsbuchstabe Vorname Vater
3. Geburtsmonat
4. Das wievielte geborene Kind
5. Anzahl Geschwister (inklusive sich selbst)

Wenn also Ihre Mutter Johanna und Ihr Vater Herbert heißt, Sie im März geboren sind und das zweitgeborene von drei Geschwistern sind, dann tragen Sie folgenden Code ein:

J	H	03	2	3

Bitte tragen Sie Ihren Code hier ein:

Bei Fragen oder Anmerkungen wenden Sie sich bitte an: Sarah Oeste-Reiß, oeste-reiss@uni-kassel.de

Demografische Daten
Im Folgenden bitten wir Sie, noch einige Angaben zu Ihrer Person und zu Ihrem Beruf zu machen.

Alter	_____ Jahre
Geschlecht	☐ weiblich ☐ männlich
Welchen Beruf / welche Tätigkeit üben Sie aus?	bitte angeben: ________________________________ wenn Studierende/r: welches Studienfach? ____________________
Wie viel Berufserfahrung haben Sie?	_____ Jahre
Welche Ausbildung haben Sie absolviert?	□ kein Abschluss □ abgeschlossene Lehre □ Meisterprüfung o. Abschluss einer Fachschule □ Diplom, Magister o. ä.

Wissenstest (Bitte kreuzen Sie an, ob die Aussage wahr oder falsch ist)

Aussage	Wahr	Falsch
Collaboration Engineering ist ein Ansatz zur Entwicklung und Umsetzung von Kollaborationsprozessen, die von Pracitioners ausgeführt werden können, um hochwertige, wiederkehrende Aufgaben zu erfüllen.		
Kollaoboration ist die Arbeit von zwei oder mehr Individuen an gemeinsamem Material, die bewusst planvoll darauf ausgerichtet wurde, ein gemeinsames Gruppenziel zu erreichen. Zur Erreichung des Gruppenziels sind Kommunikation, Konstruktion, Koordination und Kooperation der beteiligten Akteure notwendig.		
Im Collaboration Engineering wird zwischen den Rollen des Facilitator, Practitioner und Collaboration Engineer unterschieden. Der Collaboration Engineer entwickelt dabei eine kollaborative Vorgehensweise und unterstützt die Practitioners bei der Durchführung.		
Bei der Zerlegung der Gruppenaktivitäten anhand der Patterns of Collaboration (Generieren, Reduzieren, Verdeutlichen, Evaluieren, Konsens bilden) ist die Reihenfolge der Patterns grundsätzlich variabel.		
Gründe für die Nicht-Nutzung von IT Systemen sind vornehmlich in technischen Aspekten zu sehen. Um Nutzung für ein IT-System zu steigern, sollte daher zunächst die Technik verbessert werden und im Anschluss der dahinter liegende Zusammenarbeitsprozess analysiert werden.		

Persönlicher Wissensstand (Bitte kreuzen Sie eine Abstufung an, wie Sie Ihr Wissen einschätzen!)

	Wert in [%]	**Sehr gering** Ich Thema	**Gering** Ich Thema	**Mittel** Ich Thema	**Hoch** Ich Thema	**Sehr hoch** Ich Thema
Mein Wissen zur *Erstellung eines Drehbuches* für ein Erklärvideo ist…						
Mein Wissen zum Thema *Collaboration Engineering (Definition, Rollen, Designentwicklung)* ist…						

Angaben zum individuellen Lernprozess

	Vorlesung	**Lehrbuch**	**Projektarbeit**	**Sonstiges**
Bitte tragen Sie anteilig ein, wo Sie das Wissen erworben haben. (100% verteilt auf...) Vorwissen zum Thema Collaboration Engineering habe ich mir angeeignet durch…	%	%	%	%

Appendix 3 Post Evaluation Measures

Damit wir Ihre Aussagen einander zuordnen können, tragen Sie bitte einen Code nach dem folgenden Schema ein:

1. Anfangsbuchstabe Vorname Mutter
2. Anfangsbuchstabe Vorname Vater
3. Geburtsmonat
4. Das wievielte geborene Kind
5. Anzahl Geschwister (inklusive sich selbst)

Wenn also Ihre Mutter Johanna und Ihr Vater Herbert heißt, Sie im März geboren sind und das zweitgeborene von drei Geschwistern sind, dann tragen Sie folgenden Code ein:

J	H	03	2	3

Bitte tragen Sie Ihren Code hier ein:

Bei Fragen oder Anmerkungen wenden Sie sich bitte an: Sarah Oeste-Reiß, oeste-reiss@uni-kassel.de

Wissenstest (Bitte kreuzen Sie an, ob die Aussage wahr oder falsch ist)

Aussage	Wahr	Falsch
Collaboration Engineering ist ein Ansatz zur Entwicklung und Umsetzung von Kollaborationsprozessen, die von Pracitioners ausgeführt werden können, um hochwertige, wiederkehrende Aufgaben zu erfüllen.		
Kollaoboration ist die Arbeit von zwei oder mehr Individuen an gemeinsamem Material, die bewusst planvoll darauf ausgerichtet wurde, ein gemeinsames Gruppenziel zu erreichen. Zur Erreichung des Gruppenziels sind Kommunikation, Konstruktion, Koordination und Kooperation der beteiligten Akteure notwendig.		
Im Collaboration Engineering wird zwischen den Rollen des Facilitator, Practitioner und Collaboration Engineer unterschieden. Der Collaboration Engineer entwickelt dabei eine kollaborative Vorgehensweise und unterstützt die Practitioners bei der Durchführung.		
Bei der Zerlegung der Gruppenaktivitäten anhand der Patterns of Collaboration (Generieren, Reduzieren, Verdeutlichen, Evaluieren, Konsens bilden) ist die Reihenfolge der Patterns grundsätzlich variabel.		
Gründe für die Nicht-Nutzung von IT Systemen sind vornehmlich in technischen Aspekten zu sehen. Um Nutzung für ein IT-System zu steigern, sollte daher zunächst die Technik verbessert werden und im Anschluss der dahinter liegende Zusammenarbeitsprozess analysiert werden.		

Persönlicher Wissensstand (Bitte kreuzen Sie eine Abstufung an, wie Sie Ihr Wissen einschätzen!)

	Wert in [%]	**Sehr gering** Ich Thema	**Gering** Ich Thema	**Mittel** Ich Thema	**Hoch** Ich Thema	**Sehr hoch** Ich Thema
Mein Wissen zur *Erstellung eines Drehbuches* für ein Erklärvideo ist…						
Mein Wissen zum Thema *Collaboration Engineering (Definition, Rollen, Designentwicklung)* ist…						

Zufriedenheit mit dem Workshop (Bitte kreuzen Sie zutreffendes an!)

Ablauf des Workshops

	1 Stimme gar nicht zu				**5 stimme völlig zu**
Ich bin mit der Leitung des heutigen Workshops zufrieden.					
Ich habe mich mit der Durchführung des Workshop-Prozesses wohl gefühlt.					
Ich bin mit dem Verlauf des Workshops zufrieden.					
Ich bin mit den im Workshop angewendeten Methoden/ Werkzeugen zufrieden.					
Ich bin mit der Durchführung unserer Aktivitäten zufrieden.					

Zum Einsatz gekommene Werkzeuge im Workshop

Mit den im Workshop zum Einsatz gekommenen Werkzeugen habe ich mich gefühlt….	Sehr Unwohl	Unwohl	Neutral	wohl	Sehr wohl
Die zum Einsatz gekommenen Werkzeuge waren in der Nutzung/Bedienung…	Sehr schwierig	Schwie-rig	Neutral	leicht	Sehr leicht
Herauszufinden, wie die Werkzeuge funktionieren war…	Sehr schwierig	Schwie-rig	Neutral	leicht	Sehr leicht
Herauszufinden, was wir mit den Werkzeugen tun sollen war…	Sehr schwierig	Schwie-rig	Neutral	leicht	Sehr leicht
Herauszufinden, wie die Werkzeuge uns bei der Aufgabenbearbeitung unterstützen sollen war…	Sehr schwierig	Schwie-rig	Neutral	leicht	Sehr leicht

Nachvollziehbarkeit des Ablaufs des Workshops

	1 Sehr schwierig				**5 Sehr leicht**
Das Gruppenziel zu verstehen, war…					
Zu verstehen, was das Ergebnis ist, welches entwickelt werden sollte, war…					
Den (Zusammenarbeits-)Prozess zu verstehen, dem wir folgten war…					
Dem (Zusammenarbeits-)Prozess zu folgen, war…					
Fokussiert auf die Aufgabenbearbeitung zu bleiben, war…					

Zufriedenheit mit dem Ergebnis des Workshops (Bitte kreuzen Sie zutreffendes an!)

	1 Stimme gar nicht zu				**5 stimme völlig zu**
Ich mag den Ausgang des heutigen Workshops.					
Ich bin zufrieden mit den Dingen, die wir im heutigen Workshop erreicht haben.					
Nach Beendigung des Workshops bin ich zufrieden mit den Ergebnissen.					
Unsere heutige Leistung gibt mir ein Gefühl von Zufriedenheit.					
Ich bin glücklich mit den Ergebnissen des heutigen Workshops.					

In wie vielen Workshops haben Sie ähnliche Werkzeuge und Methoden wie in dem heutigen Workshop benutzt?

0	1 bis 2	3 bis 5	6 bis 10	mehr als 10

Sonstige Anmerkungen und Verbesserungsvorschläge

Was möchten Sie zusätzlich noch anmerken, zum Beispiel: Was hat Ihnen besonders gut oder überhaupt nicht an dem Workshop gefallen?

____

____

____

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____

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Appendix B. HLL Design Theory

Appendix 4 Collaborative Task: Case with its Four Subtasks

Case	You are a trainee in a small trading company, which sells its goods via stationary trading and additionally wants to set up an online shop. The company´s innovation management wants to address the increasing digitalization and gives you the following tasks.
Subtask 1	The innovation management wants to address the increasing digitalization with new payment systems like paying with a mobile phone or a smartwatch. At the coming meeting you have to introduce the possible applications of digital media in retail trade. Moreover you have to present recommendations how to shift to the new payment system. In your team gather examples how the digitalization influences the retail trade, its data models and business processes. Illustrate the model-based task solving on the example of a payment system introduction. Explain the process from the as-is till the target state as well the process from the target till the as-is state.
Subtask 2	The innovation management wants to address the increasing digitalization with an online shop. At the coming meeting you have to present recommendations for its introduction. For that goal you´ve learnt that the reference models are a suitable way to introduce new processes in a company. Present advantages and disadvantages of reference models and show them on the case study, that you´ve learnt from the lecture´s videos. Develop in a team a reference model for the online payment procedure in a small trading company. Follow sector-specific purchase procedures of the well-known online shops. Explain with the help of your model different construction techniques, which are used to design reference models.
Subtask 3	The innovation management wants to address the increasing digitalization with a new payment system, like paying with a mobile phone or a smartwatch. At the coming meeting you have to present how the application systems can be implemented. Explain the possible applications of a CRM system in a company. Concentrate on how a CRM system supports the user-, benefit- and usage-orientation. Refer to the online as well the stationary trading and give examples, where CRM systems connect online trading with the stationary trading. Explain on this example the relation between the CRM and ERP system.
Subtask 4	The innovation management wants to address the increasing digitalization with an ERP system. At the coming meeting you have to present recommendations how applications systems can be implemented. Explain the ERP implementation in a trading company and describe the benefit of ERP systems within the SCM. Explain the benefit of ERP systems for the operative, middle and top management.

Appendix 5 Pre- and Post-Evaluation: Knowledge Test

The table describes the true/false-questions used in the pre- and post-tests. KT1 and KT2 refer to subtask 1, KT3 and KT4 refer to subtask 2, KT5 and KT6 refer to subtask 3, KT7 and KT8 refer to subtask 4. Every learner had to answer questions on all of the domain knowledge.

True/False-Questions		**Pre-test**	**Post-test**
KT1	The model-based problem solving serves to minimize risks. If you have to describe this, you would do this as follows: Starting from the as-is state a prescriptive model (role model) is developed. A descriptive model (display) is then drafted by a role model modification. It serves as a reference point for the target state and is realized in the last step. (false)	x	x
KT2	If you have to develop a model, that gives notes for a user how to implement an information system according to design-oriented aspects, you should draft a descriptive model. (false)		x
KT3	The reference models can be developed on the basis of field specific structures, for example sector reference models or standard software reference models. (true)	x	x
KT4	If you notice that a reference model suggests how to arrange a class of models, it is an index of a descriptive reference model. (false)		x
KT5	Cross-sectional systems are an application system type. They are used by all target groups in a company for different planning horizons. They are divided into sector-neutral and sector-specific cross-sectional systems. (false)	x	x
KT6	If you have to summarize all company´s relations with its customers in one application system, you should use a CRM-system that refers the information from other application systems to the ERM-system. (correct)		x
KT7	You want to get an overview of the overall business processes in a company. Use PPS for that. (false)	x	x
KT8	Planning systems support the planning process by calculating the alternative accounts. If you want to use qualitative models to carry out alternative accounts, you should apply multifactor methods and cost-benefit analysis. (true)		x
‘pre-and-post-questions’	LLL_KT_1357		
‘post-only-questions’	LLL_KT_2468		
‘8-questions’	LLL_KT_12345678		

Appendix 6 Treatment Sample (with HLL-PSA): Moodle, Google Docs / Slides

HLL-PSA - Step 1: Registration – Individual (Asynchronous)

Moodle

In order to get access to the case and its tasks you have to register for the HLL-experience.

The link provides you a video-walkthrough for the ‘phase 2: training and task solving’.

Registration

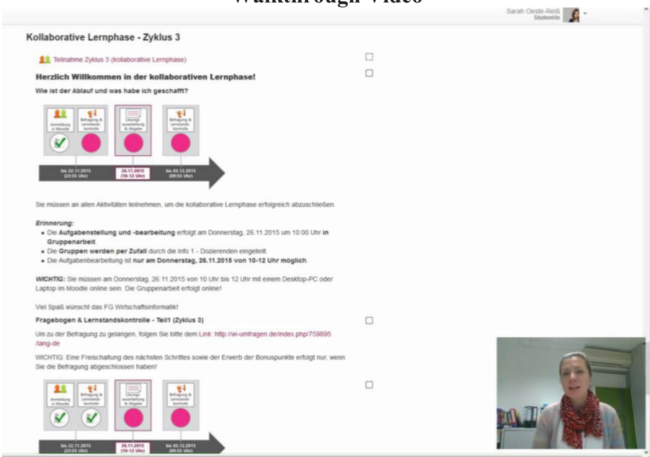
Dear students, if you want to participate to the HLL-experience, you have to register here

Note: Only registered students will get access to the task description and receive lecturer-feedback. You will have to solve one sub-task collaboratively.

Registration is open until ‘DATE I 11:55 pm’

selection	description
○	binding registration

Walkthrough Video



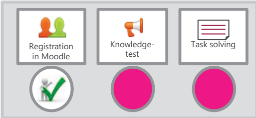
HLL-PSA - Step 2: Knowledge Test – Individual (Asynchronous)

Moodle

Welcome to the HLL-experience

You have to complete all steps (register – knowledge-test – task solving) in order to successfully complete the HLL-experience. Enjoy yourself!

Which things did I complete and what are the next steps?



Reminder:

- The description of the case and sub-tasks as well as further instructions will be released on DATE, TIME.
- The task solving takes place in online groups! The lecturer will randomly assign you to a group and one sub-task.
- The task solving takes place synchronously at DATE.

Important: On DATE, TIME you must be logged in Moodle with a laptop or desktop pc.

Knowledge-Test

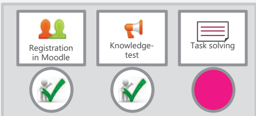
In order to participate to the knowledge-test, please follow the **link**.

Knowledge-Test

Introduction screen of the survey

End screen of the survey Thank you for participating! The task description will be unlocked on DATE, TIME!

Which things did I complete and what are the next steps?



- ☑ Self-directed acquisition of domain knowledge content 'text'.
- ☑ Be on a working place at DATE without distractions.
- ☑ Be online with a laptop or desktop-pc.
- ☑ Do NOT get together in groups for yourself! The grouping is randomly and you receive all information during DATE, TIME
- ☑ Be online 15 min before the collaboration starts in order to test whether your technic works
  - Internet access
  - Moodle log-in
- ☑ Reload the Moodle course for several times in order to ensure that you receive all information

We will support you during the collaborative task solving when you are in the several groups. Enjoy yourself

< picture of instructors sitting in one room on their laptops>

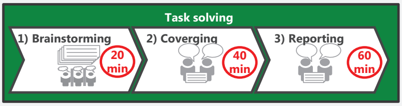
HLL-PSA - Step 3: Brainstorming – Subgroups (Synchronous)

Moodle

Unlocked instructions, when the synchronous collaboration starts

What do I have to do in order to solve the task?
The task solving takes place in three steps (see figure).

- Step 1: You are assigned automatically to a sub-group. Brainstorming of for ideas for the solution for all four sub-tasks within a sub-group (24 group-members)
- Step 2,3: You are automatically assigned to a breakout-group and a sub-task in which you work on the solution for one sub-task.



For every step a defined time frame is available. Please, take notice of the time. The documents can only be edited in the defined timeframes.

How to get access to a document/ shared writing page?
After a time frame, a link is unlocked automatically in within your moodle group.

How can I discuss and interact with my group members?
In the Google Docs and Google Slides documents you will find tables. Use the tables in order to ask questions and respond to them.

Who is in my sub-group?
< table with group members >

Follow the *link* to 'Brainstorming'

Google Docs

Instructions – What shall I do?

- Read the case description and the four tasks!
- If there is a task on which you have less or no knowledge, go to the next task. Nevertheless, try to work on every task!
- On your own write down aspects for the solution of every task in the form of keywords!
- All group members can read, edit and comment the aspects for the solution from other group members.

Note: At the end of the time…

- The group becomes randomly divided into breakout groups. Every breakout group receives one of the tasks in order to prepare a detailed solution for the task.
- A red box appears at the top of the document with further instructions.

Red box: "Editing time is over!"

- Now you are only able to read the document. Editing is not possible anymore.
- Please move to the Moodle course. Reload the Moodle page, in order to ensure that all content is displayed to you.
- In the Moodle course you will see the next link with further instructions.

HLL-PSA - Step 4: Converging – Breakout groups (Synchronous)

Moodle

[…]

Who is in my breakout-group?
An overview with the members of your sub-group is unlocked for you at step 2.

Follow the *link* to 'Convering'

Google Docs

Instructions – What shall I do?
- Now you are in a breakout group (see table for group-members) and you are assigned to one of the tasks. Read the aspects for the solution of your assigned task!
- Discuss with your group-members the aspects of the solution. Use the table in order to ask questions and write down answers.
- Summarize double aspects of the solution. Write down and add missing aspects for the solution.
- Copy your aspects of solution into the table at the bottom of the document. Evaluate in which of the columns you copy the aspects of solution.
- Left column: relevant (correct) aspects of the solution.
- Right column: not relevant (false) aspects of the solution.

Note: At the end of time…
- you can only read the document. Editing (e.g. write down contributions) is not possible any more.
- a red box appears at the top of the document with further instructions.

Red box: "Editing time is over!"
- You are only able to read the document. Editing is not possible any more.
- Please move to the Moodle course. Reload the Moodle page in order to ensure that all content is displayed to you.
- In the Moodle course you will see the next link with further instructions.

HLL-PSA - Step 4: Reporting – Breakout groups (Synchronous)

Moodle

[…]

Follow the *link* to 'Reporting'

Google Slides

Instructions – What shall I do?

- Now you are still in your breakout group (see table for group-members).
- Discuss with your group-members, how you can present the solution on 5 slides and how you want to organize yourself. Use the table in order to ask questions and write down answers.
- Summarize on 5 slides a solution in a correct, structured and meaningful manner.
- Visualize your solution.
- Use meaningful phrases / short summarizations.

Note: At the end of the time…

- you can only read the document. Editing (e.g. write down contributions) is not possible anymore.
- a read box appears at the top of the document with further instructions.

Red box: "Editing time is over!"

- Now you are only able to read the document. Editing is not possible anymore.
- Please move to the Moodle course. Reload the Moodle page, in order to ensure that all content is displayed to you.
- In the Moodle course you will get access to the link to the survey. You must participate to the post-evaluation in order to complete the HLL experience.

Appendix 7 Control Sample (without HLL-PSA): Google Docs / Slides Google

The moodle instructions for the control sample were the same as the ones in the treatment sample of steps 1 (registration) and step 2 (knowledge test). After those steps, moodle unlocked the learners in the control sample two links and guided them to a Google Docs and a Google Slides Document. Each document comprised the description of a subtask and the instructions to solve the task. Following I outline the instructions to solve the tasks that were printed in both Google documents.

Google Docs / Google Slides

Instructions – What shall I do?

- Now you are in a breakout group (see table for group-members).
- Read the case description and the task.
- You have to organize yourself in the group in order to solve and write down the solution of the task.
- There are two documents available which you can use for your collaboration.
    - Google Word: e.g. for notes, discussions, partial solutions.
    - Google Slides: e.g. demonstration of the final solution.
- Discuss with your group members the aspects of solution. Use the table in order to ask questions and write down answers.
- At the end of the time the solution of the task…
    - must be solved in a correct manner with all relevant aspects of the solution
    - must be reported on 5 slides in a structured and meaningful manner (e.g. keywords, visualizations, summarizations)

Note: At the end of the time…

- you can only read the document. Editing (e.g. write down contributions) is not possible anymore.
- a read box appears at the top of the document with further instructions.

Red box: “Editing time is over!”

- Now you are only able to read the document. Editing is not possible anymore.
- Please move to the Moodle course. Reload the Moodle page, in order to ensure that all content is displayed to you.
- In the Moodle course you will get access to the link to the survey. You must participate to the post-evaluation in order to complete the HLL experience.

Appendix 8 Measures

Post-Evaluation: Survey Variables

Tool Difficulty (TOOLDIF) (Briggs et al. 2013)
The tool we used today were (very difficult/ very easy) to use. How difficult was it to figure out how the tool worked? (very difficult, very easy) How difficult was it to figure out what we were supposed to do with the tool? (very difficult, very easy) How difficult was it to understand how the tools were supposed to support our task? (very difficult, very easy)
Satisfaction with Process (SP) (Briggs et al. 2013)
I feel good about today's HLL experience. I liked the way the HLL experience progressed today. I feel satisfied with the procedures used in today's HLL experience. I feel satisfied about the way we carried out the activities in today's HLL experience.
Satisfaction with Outcome (SO) (Briggs et al. 2013)
I liked the outcome of today's HLL experience. I feel satisfied with the things we achieved in today's HLL experience. When the HLL experience was over, I felt satisfied with the results. Our accomplishments today give me a feeling of satisfaction. I am happy with the results of today's HLL experience.
Efficiency (Kolfschoten 2007)
I found the HLL experience worth the time and effort. The time and effort requested from me was reasonable. I was able to contribute relevant knowledge and experience I had for the meeting. The time and effort I spend in the HLL experience was what I expected. My input was justified.
Effectiveness (Kolfschoten 2007)
The result of the HLL experience had the quality I expected. What we achieved today met my expectations. We achieved what we intended. The result has the quality intended. The result was as I hoped.
Productivity (Kolfschoten 2007)
The input asked from me was in balance with the results. The result was not a waste of my time and effort. What we achieved was worth the time and effort. What we achieved was worth the time and effort. The quality of the results is in balance with the time and effort asked for me. The quality of the results justifies my input.
Perceived Team Performance (Benalian 201X)
This team is consistently a high-performing team. This team makes few mistakes. This team's deliverables were of excellent quality.

Original, Adapted and Translated Variables

Satisfaction with Process (SP) (Briggs et al. 2013)		
Original construct (5-point scale)	*Adapted construct [English]*	*Construct used in survey [German]*
SP1: I feel satisfied with the way in which today's meeting was conducted. SP2: I feel good about today's meeting process. SP3: I liked the way the meeting progressed today. SP4: I feel satisfied with the procedures used in today's meeting. SP5: I feel satisfied about the way we carried out the activities in today's meeting.	~~SP1: I feel satisfied with the moderation by which the HLL experience was conducted.~~ SP2: I feel good about today's HLL experience. SP3: I liked the way the HLL experience progressed today. SP4: I feel satisfied with the procedures used in today's HLL experience. SP5: I feel satisfied about the way we carried out the activities in today's HLL experience.	~~SP1: Ich bin mit der Moderation der kollaborativen Lernphase zufrieden.~~ SP2: Ich habe mich mit der Durchführung der kollaborativen Lernphase wohl gefühlt. SP3: Ich bin mit dem Verlauf der kollaborativen Lernphase zufrieden. SP4: Ich bin mit den in der kollaborativen Lernphase angewendeten Methoden/ Werkzeugen zufrieden. SP5: Ich bin mit der Durchführung unserer Aktivitäten zufrieden.
Satisfaction with Outcome (SO) (Briggs et al. 2013)		
Original construct (5-point scale)	*Adapted construct [English]*	*Construct used in survey [German]*
SO1: I liked the outcome of today's meeting, SO2: I feel satisfied with the things we achieved in today's meeting. SO3: When the meeting was over, I felt satisfied with the results. SO4: Our accomplishments today give me a feeling of satisfaction. SO5: I am happy with the results of today's meeting.	SO1: I liked the outcome of today's HLL experience. SO2: I feel satisfied with the things we achieved in today's HLL experience. SO3: When the HLL experience was over, I felt satisfied with the results. SO4: Our accomplishments today give me a feeling of satisfaction. SO5: I am happy with the results of today's HLL experience.	SO1: Ich mag den Ausgang der kollaborativen Lernphase. SO2: Ich bin zufrieden mit den Dingen, die wir in der kollaborativen Lernphase erreicht haben. SO3: Nach Beendigung der kollaborativen Lernphase bin ich zufrieden mit den Ergebnissen. SO4: Unsere Leistung gibt mir ein Gefühl von Zufriedenheit. SO5: Ich bin glücklich mit den Ergebnissen der kollaborativen Lernphase.

Tool Difficulty (TOOLDIF) (Briggs et al. 2013)

Original construct (5-point scale)	*Adapted construct [English]*	*Construct used in survey [German]*
TOOLDIF1: I was (uncomfortable/ comfortable) with the tool we used today. (very uncomfortable, uncomfortable, neutral, comfortable, very comfortable).	~~TOOLDIF1: I was (uncomfortable/ comfortable) with the tool we used today. (very uncomfortable, uncomfortable, neutral, comfortable, very comfortable).~~	~~TOOLDIF1: Mit den in der kollaborativen Lernphase zum Einsatz gekommenen Werkzeugen habe ich mich…gefühlt. (sehr unwohl, unwohl, neutral, wohl, sehr wohl).~~
TOOLDIF2: The tool we used today were (difficult/easy) to use. (very difficult, difficult, neutral, easy, very easy).	TOOLDIF2: The tool we used today were (difficult/easy) to use. (very difficult, difficult, neutral, easy, very easy).	TOOLDIF2: Die zum Einsatz gekommenen Werkzeuge waren in der Nutzung/Bedienung… (sehr schwierig, schwierig, neutral, leicht, sehr leicht).
TOOLDIF3: How difficult was it to figure out how the tool worked? (very difficult, difficult, neutral, easy, very easy).	TOOLDIF3: How difficult was it to figure out how the tool worked? (very difficult, difficult, neutral, easy, very easy).	TOOLDIF3: Herauszufinden, wie die Werkzeuge funktionieren war… (sehr schwierig, schwierig, neutral, leicht, sehr leicht).
TOOLDIF4: H ow difficult was it to figure out what we were supposed to do with the tool? (very difficult, difficult, neutral, easy, and very easy).	TOOLDIF4: How difficult was it to figure out what we were supposed to do with the tool? (very difficult, difficult, neutral, easy, and very easy).	TOOLDIF 4: Herauszufinden, was wir mit den Werkzeugen tun sollen war… (sehr schwierig, schwierig, neutral, leicht, sehr leicht).
TOOLDIF5: H ow difficult was it to understand how the tools were supposed to support our task? (very difficult, difficult, neutral, easy, and very easy).	TOOLDIF5: How difficult was it to understand how the tools were supposed to support our task? (very difficult, difficult, neutral, easy, and very easy).	TOOLDIF5: Herauszufinden, wie die Werkzeuge uns bei der Aufgabenbearbeitung unterstützen sollen war… (sehr schwierig, schwierig, neutral, leicht, sehr leicht).

Efficiency (Kolfschoten 2007)		
Original construct (7-point scale)	*Adapted construct [English]*	*Construct used in survey [German]*
Effic1: I found the meeting worth the time and effort. Effic2: The time and effort requested from me was reasonable. Effic3: I was able to contribute relevant knowledge and experience I had for the meeting. Effic4: The time and effort I spend in the meeting was what I expected. Effic5: My input was justified.	Effic1: I found the HLL experience worth the time and effort. Effic2: The time and effort requested from me was reasonable. Effic3: I was able to contribute relevant knowledge and experience I had for the meeting. Effic4: The time and effort I spend in the HLL experience was what I expected. Effic5: My input was justified.	Effic1: Ich fand die kollaborative Lernphase, was die Zeit und den Arbeitsaufwand anbelangt, lohnend. Effic2: Die Zeit und der Arbeitsaufwand, der von mir verlangt wurde, war angemessen. Effic3: Ich konnte relevantes Wissen und meine Erfahrungen in die kollaborative Lernphase einbringen. Effic4: Die in die kollaborative Lernphase investierte Zeit und der Arbeitsaufwand entsprachen dem, was ich erwartet hatte. Effic5: Mein Input wurde gerechtfertigt.
Effectiveness (Kolfschoten 2007)		
Original construct (7-point scale)	*Adapted construct [English]*	*Construct used in survey [German]*
Effect1: The result of the meeting had the quality I expected. Effect2: What we achieved today met my expectations. Effect3: We achieved what we intended. Effect4: The result has the quality intended. Effect5: The result was as I hoped.	Effect1: The result of the HLL experience had the quality I expected. Effect2: What we achieved today met my expectations. Effect3: We achieved what we intended. Effect4: The result has the quality intended. Effect5: The result was as I hoped.	Effect1: Die Ergebnisse der kollaborativen Lernphase entsprechen der erwarteten Qualität. Effect2: Das was wir heute erreicht haben entspricht meinen Erwartungen. Effect3: Wir haben das erreicht was wir beabsichtigt haben. Effect4: Die Ergebnisse haben die beabsichtigte Qualität. Effect5: Das Ergebnis war wie ich gehofft habe.

Productivity (Kolfschoten 2007)		
Original construct (7-point scale)	*Adapted construct [English]*	*Construct used in survey [German]*
Prod1: The input asked from me was in balance with the results. Prod2: The result was not a waste of my time and effort. Prod3: What we achieved was worth the time and effort. Prod4: What we achieved was worth the time and effort. Prod5: The quality of the results is in balance with the time and effort asked for me. Prod6: The quality of the results justifies my input.	Prod1: The input asked from me was in balance with the results. Prod2: The result was not a waste of my time and effort. Prod3: What we achieved was worth the time and effort. Prod4: What we achieved was worth the time and effort. Prod5: The quality of the results is in balance with the time and effort asked for me. Prod6: The quality of the results justifies my input.	Prod1: Der von mir geforderte Input war in Balance mit den Ergebnissen der kollaborativen Lernphase. Prod2: Die Ergebnisse der kollaborativen Lernphase sind keine Verschwendung von Zeit und Arbeitsaufwand. Prod3: Das was wir erreicht haben war die Zeit und den Arbeitsaufwand wert. Prod4: Die Qualität der Ergebnisse ist in Balance mit der von mir geforderten Zeit und Arbeitsaufwänden. Prod5: Die Qualität der Ergebnisse rechtfertigt meinen Input.
Perceived Team Performance (Benalian 201X)		
Original construct (7-point scale)	*Adapted construct [English]*	*Construct used in survey [German]*
TP1: This team is consistently a high-performing team. TP2: This team is effective. TP3: This team makes few mistakes. TP4: This team’s deliverables were of excellent quality.	TP1: This team is consistently a high-performing team. ~~TP2: This team is effective.~~ TP3: This team makes few mistakes. TP4: This team’s deliverables were of excellent quality.	TP1: Das Team ist durchweg ein äußerst leistungsfähiges Team. ~~TP2: Das Team ist effektiv.~~ TP3: Das Team macht wenig Fehler. TP4: Die Ergebnisse des Teams waren oft von exzellenter Qualität.

The digitization changes qualification demands of knowledge workers and opens new forms of collaboration. Solutions are required for enhancing acquisition and transfer of knowledge as well as training professional skills such as critical thinking, communication and cooperation.

Peer Learning (PL) provides potentials for coping with these demands. However, it faces practical challenges as its reusability is low, collaboration expertise is required, and lacks leveraging digitization potentials. In contrast, the body of Collaboration Engineering (CE) literature, provides insights as it is an approach to designing collaborative work practices for high-value recurring tasks and deploying those to practitioners to execute for themselves without collaboration expertise.

In this light, three research questions shape the structure of the thesis. First, the thesis shows an analysis of the application domain and develops a teaching-learning approach for creating conditions for PL in large scale lectures. Second, it proposes an approach to designing reference processes for enhancing PL. Third, it presents three studies that illustrate the design, instantiation and evaluation of reference processes for enhancing PL in the field. As methodological approach the thesis uses Design Science and develops, instantiates and evaluates re-usable reference processes for enhancing PL.

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