1 Towards a Design-Oriented Approach for the Investigation of Self-Regulated Personalised Blended Learning

In a world of increasing complexity driven by the megatrends of globalisation and digitalisation, proper education is becoming increasingly important. Requirements regarding knowledge, skills, and abilities for individuals are constantly rising with the advancing integration and standardisation of markets, transportation, and communication infrastructure reinforced by digital technologies. While education in previous decades was largely bound to formal face-to-face learning in schools, higher education institutions, or professional trainings, the advent of the worldwide web as the global infrastructure for knowledge exchange and collaboration led to disruptive changes redefining education and learning (Tapscott and Williams 2010): (1) Learning is informal as it is performed more often at home or at the workplace in a self-regulated manner, addressing the notion of life-long learning in keeping up with a steadily growing body of knowledge (Marsick and Watkins 2001); (2) Learning is supported by electronic means which quickly developed from a mere substitute of traditional learning to augmenting, modifying, and even redefining learning (Puentedura 2003); (3) Learning is ubiquitous and even electronic support only requires access to the Internet, which is accessible to more and more people from all around the globe in a broad range of situations (Heggestuen 2013); (4) Learning is social with social media encouraging Internet users in the co-creation and exchange of knowledge leading to the formation of online communities and collaborative learning in electronic environments (Brown and Adler 2008).

1.1 Equal Progressions in Pedagogy and Technology

Combining these developments, electronic learning promises benefits such as cost efficiency, availability, flexibility, repeatability, convenience, and consistency (Acton et al. 2005; Gunasekaran et al. 2002), while also showing disadvantages such as missing social context, delayed feedback, or unclear learning objectives (Renner et al. 2015). Blended learning, which is defined as the meaningful integration of face-to-face and online learning (Garrison and Vaughan 2011), aims to provide the best of both worlds. In scenarios where face-to-face meetings as well as online learning are possible (such as in traditional higher education), blended learning has

P. Melzer, *A Conceptual Framework for Personalised Learning*,
https://doi.org/10.1007/978-3-658-23095-1_1

been found to be a very promising approach to teaching and learning (Hill et al. 2016; Garrison and Vaughan 2011). Blended learning, in various forms, is already today's standard form of learning at German universities supporting presence lectures with the online provision of learning materials or communication facilities (Persike and Friedrich 2016). Currently over 500 different Virtual Learning Environments (VLEs) are on the market worldwide, representing a strongly segmented market regarding different industries, educational institutions, regions, and features. Market growth is projected to be up to 23.17% for 2017 and 2018. The most popular VLEs according to their number of customers are Edmodo, Moodle, Blackboard, and Collaborize Classroom (Pappas 2015; Hill 2015). The VLE ILIAS ("Integriertes Lern-, Informations- und Arbeitskooperationssystem" German for Integrated Learning, Information, and Work Cooperation System), which is primarily used in Western Europe and will be used in this thesis, cites installations at 91 higher education institutions worldwide (ILIAS e.V. 2016). Blended learning is, therefore, evaluated as a short-term trend being easily implementable (Johnson et al. 2016).

The described technological progress in learning is complemented by a similar development within pedagogy. In the year 1910, John Dewey (1997, p. 46) noted the core idea of personalised learning for the first time describing the goal of teaching to be

> "concerned with providing conditions so adapted to individual needs and powers as to make for the permanent improvement of observation, suggestion, and investigation."

However, these ideas have been overshadowed by the prominent learning theories of the following decades, namely behaviourism (Skinner 1958) and cognitivism (Tennyson 1992), which focus on learning processes as a transmission of knowledge from teacher to learner. Behaviourism considers the human mind as a black box focusing on input and output of stimuli. The teacher is the dominant actor as she exerts such stimuli to trigger learning processes. Desired learning behaviour must then be reinforced while undesired learning behaviour must be punished to improve learning. Behaviourist learning methods often focus on rote learning. For example, memorising the vocabulary of a language. As a countermovement to behaviourism, cognitivism investigates the interior of the behaviourist black box, aiming to disentangle the process of human understanding. In con-

trast to behaviourism, learning is now seen as an activity building on cognitive abilities and prior knowledge of the learners. Learning outcomes are influenced by the learner's metacognition and what is learnt (Shuell 1986). However, only the constructivist learning paradigm (Papert 1993; Harel and Papert 1993) takes up Dewey's considerations going even further and changing education drastically by making the learners themselves responsible for their learning. According to constructivism, there is no knowledge transmission from teacher to learner. Instead, the learners explore and construct knowledge themselves based on their experiences. Constructionism, furthermore, emphasises the importance of situated and collaborative learning (Kafai 2006). Communication and discussion between the teacher as a moderator and the learners as well as between learners themselves are key to confirm the constructed knowledge. The remainder of this thesis will adhere to the constructionist paradigm in particular.

Dewey – rediscovered as an early proponent of constructionist ideas (Brown 1992) – emphasised the relevance of individual needs and powers showing that there is no one-size-fits-all-approach to learning. This is reflected in a shift from clearly defined syllabi to competence-based learning (Erpenbeck and Hasebrook 2011), where learners are able to choose what they want to learn in a self-regulated way, thus, reflecting increasing heterogeneity within the learners and their requirements (Tsai et al. 2013). Such heterogeneity can be divided into persistent characteristics (e.g. gender, age), semi-persistent characteristics (e.g. level of competence, personality traits, or learning styles) that may change slowly over time, and volatile characteristics (e.g. emotional states) that influence the learning process (Gupta et al. 2010). Among the aforementioned influence factors, probably the most intensively used measure of personalisation in learning are learning styles. Drawing from psychological types (Jung 1923) and personality traits (e.g. the Myers Briggs Type Indicator; Myers et al. 1985), over 70 different theories of learning styles were published that can be grouped into five families, ranging from constitutionally based theories to volatile learning approaches (Coffield et al. 2004). In conjunction with the notion of personalised learning, these learning style theories are often easy to understand concepts that are used by teachers, policy makers, or managers. From a scientific point of view, they often contradict each other, providing inconclusive evidence (Pashler et al. 2009). In recent years, personalisation was introduced into educational institutions by policy makers or private dedication e.g. in Germany (Bönsch 2016) or the United States

of America (Bill and Melinda Gates Foundation 2014; Pane et al. 2015) to provide equal chances for all learners at the same time, increasing learning performance. Combining the pedagogical and technological perspective, personalised learning was recently named as one of the key trends for higher education (Adams Becker et al. 2017; Moore 2016; Johnson et al. 2016; Johnson et al. 2015).

1.1.1 Perspectives on Personalised Learning

Reflecting the aforementioned technological and pedagogical developments e-learning is defined as

> "electronically mediated asynchronous and synchronous communication for the purpose of constructing and confirming knowledge." (Garrison 2011, p. 2)

By adopting this definition, the impact of constructionism is acknowledged as having communication at the heart of learning. Personalised learning, furthermore, consists of differentiation and individualisation (U.S. Department of Education 2010). Whilst differentiation aims to tailor the method of teaching according to the learners' preferences, individualisation enables learners to progress through the learning material in their own pace, skipping or repeating topics if necessary. Learning goals, however, always stay the same. To implement the personalisation of learning two avenues emerged:

Self-regulated learning is usually investigated within academic learning as it requires learners to be metacognitively, motivationally, and behaviourally active in their own learning including specified learning strategies as well as perceptions of their own self-efficacy (Zimmerman 1989). Self-regulated personalised learning follows the ideas of the constructionist learning paradigm, making the learners themselves responsible for the personalisation. Consequently, the learners decide when, where, and how to tackle exercises being guided by the teacher. Electronic learning and especially blended learning are key methods to support self-regulated personalised learning, providing the necessary availability and flexibility. However, learners have to be encouraged as well as prepared for personalisation, as it requires profound knowledge about their learning preferences (i.e. metacognition) as well as digital literacy.

Adaptive learning aims to track the learning trajectory automatically, evaluating whether and how a learner performs exercises. This information

is then used to recommend further tasks, repeating the same knowledge in case the solution is incorrect or expanding to new and more complex exercises and topics. In a nutshell, adaptive learning aims to personalise learning in an automated way relying on software, building e.g. upon the ideas of intelligent tutoring systems (Anderson et al. 1985; Koedinger and Corbett 2006). Such approaches, however, require the mathematical modelling of the knowledge space (Falmagne et al. 2006; Erpenbeck and Sauter 2013) of the topic to be learned as well as learning with exercises which can be evaluated automatically. This could be achieved for mathematical education for example, while less well-structured topics such as politics can hardly be modelled like that. Recent technological innovations in the context of big data and machine learning such as learning analytics (Greller and Drachsler 2012), however, have drastically increased the interest of researchers and practitioners in this topic again, leading to several highly-valued start-ups (Emerson 2013). Whilst both approaches are very promising and might eventually converge, complementing each other (Steiner et al. 2009), this thesis focuses on the self-regulated approach towards personalised learning, empowering the learners to personalise their learning themselves.

Self-regulated personalised blended learning requires careful coordination of didactics, technology, and content. It is facilitated by constructionist learning methods focusing on situatedness, communication, and collaboration. One specific method of implementing blended learning, which particularly facilitates self-regulated personalisation, is the flipped classroom (also known as inverted classroom; EDUCAUSE Learning Initiative 2012; Feldstein and Hill 2016). While traditional teaching (e.g. in lectures) aims to present theoretical knowledge to the learners, which is in turn applied and evaluated in homework and exercises, the flipped classroom turns these phases around. The preparation phase comes first, in which the learners acquire theoretical knowledge using distant learning supported by e-learning approaches. Within this phase, learning is rather teacher-centred, presenting explicit instructions and prescriptions to the learners. The following presence phase focuses on the application and evaluation of the previously acquired knowledge in interactive role-plays, discussions and case studies. The fact that teacher and learners are co-present facilitates interaction and student-centred learning (Bishop and Verleger 2013). Besides its obvious benefits implementing self-regulated personalised blended learning (Bishop and Verleger 2013; Feldstein and

Hill 2016), flipped classrooms are used frequently in higher education and large classes (Pierce and Fox 2012; Milman 2012). Flipped classrooms require a high amount of metacognitive knowledge, self-discipline, and digital literacy of the learners to prepare before the presence lectures, which is mostly present in higher education. There, however, flipped classrooms can be used to educate large amounts of students at the same time, since the usage of electronic learning approaches enables scalable and repeatable learning. Interaction and discussion during the presence phase is guided by the lecturer, which requires profound knowledge, however, in the end discussions should be encouraged within the group of learners. Finally, the flipped classroom especially supports a large variety of learning tasks used at the same time focusing on active and collaborative learning especially suitable for learning practical procedures (Pierce and Fox 2012; Milman 2012). Literature on the design and evaluation of blended learning courses – especially flipped classrooms – remains scarce (Abeysekera and Dawson 2014; McNally et al. 2017). Apart from theoretical descriptions of underlying learning paradigms and methods, concrete teaching cases and instantiations are rarely published. Such instantiations, however, are important for practitioners who need to apply the theoretical concepts to concrete topics, lectures, and institutions. According to Findlay-Thompson and Mombourquette (2014) even for the flipped classroom there is no one-size-fits-all approach and e.g. the weight of the preparation phase and presence phase has to be adjusted carefully. Also, from a scientific point of view, evaluation methods of such flipped classroom approaches require further research, as instruments often focus solely on the presence or online phases, neglecting their integration (Bishop and Verleger 2013).

1.1.2 Research Questions and Scope

The overall research goal of this thesis is to improve learning by facilitating self-regulated personalisation. It therefore combines the described streams of self-regulated personalisation of learning with methods of blended learning, which are used to support such personalisation. The thesis therefore investigates two distinct research questions (RQs):
Research question 1: Which factors influence self-regulated personalised learning?
Research Question 2: How can self-regulated personalised learning be implemented in blended learning scenarios?

Research question 1 aims for the description of a holistic framework of self-regulated personalised learning including all relevant influence factors as well as being able to theorise how these factors shape personalised learning. Research question 1 is addressed by Melzer and Schoop (2016; cf. chapter 2), who investigate learning styles and teaching methods as a measure of personalised learning with respect to improving learning outcomes. Melzer and Schoop (2015; cf. chapter 3) theorise on the Personalised Learning Framework (PLF), a conceptual framework for personalised learning using learning tasks as the unit of personalisation dwelling on the results of Melzer and Schoop (2016).

Research question 2 is addressed by Melzer and Schoop (2017a; cf. chapter 4), consequently using the conceptual framework to implement a self-regulated personalised flipped classroom within a real university course environment. This proof-of-concept shows relevant requirements and components of such a course design as well as an evaluation approach, which is described in Melzer and Schoop (2017b; cf. chapter 5). While the transformed course remains bound to its specific topic, design requirements, components, and the approach towards evaluation are generalisable to other domains.

The thesis at hand investigates its research questions within the application domains of (electronic) negotiation teaching in higher education. Higher education, especially at universities, shows the necessity for personalised learning, as large numbers of learners with great heterogeneity have to be taught in an effective, but also scalable and cost-efficient manner. Due to lacking financial support, universities often miss sufficient personnel and time for effective teaching. On the one hand, this inhibits satisfaction of the teaching staff with their work. On the other hand, it harms student success leading to increased drop-out rates and duration of study (Leidenfrost et al. 2009). Learners in higher education match the requirements of self-regulated personalised blended learning, as they are usually experienced learners with several years of previous schooling and digital literacy.

Teaching negotiations is relevant in academic as well as practical contexts and thus, often integrated in business or information systems (IS) curricula in higher education or provided in corporate trainings directed at employees managing procurement or sales processes. Negotiation teaching requires the combination of theoretical knowledge and their application

in practical exercise to create necessary skills (Lewicki 1997). Often renowned negotiation experts are integrated into such trainings to show their best practices providing the possibility to imitate their behaviour (Loewenstein and Thompson 2006). Nowadays negotiations are often conducted using electronic media such as email (Schoop et al. 2008). Therefore, it is necessary to integrate face-to-face negotiations as well as electronic negotiation media into teaching (Köszegi and Kersten 2003). However, negotiations as a soft-skill topic usually follows intrinsic motivation to learn about it and, therefore, create large involvement with the learners (Lewicki 1997). While Melzer and Schoop (2016) analyse end-user-trainings (EUTs), where future users of the negotiation support system (NSS) Negoisst (Schoop 2010) are trained how to use it correctly to achieve their goals as part of a university lecture, Melzer and Schoop (2017a) transform and evaluate the complete university course Advanced Negotiation Management (ANM) into a self-regulated personalised flipped classroom.

1.2 A Design-Oriented Research Methodology

The present work follows a design-oriented research approach. Both – ISs and the learning sciences – engaged in design science respectively design-based research (DBR) both following a pragmatist epistemology. The paradigm of pragmatism incorporates the assumption that all research artefacts must be evaluated by their purpose (Thayer 2012). If an artefact is used in practice, it has a purpose and therefore provides utility. John Dewey (2013) describes the method of controlled inquiry as a method for common learning and scientific investigation to uncover new generalisable truths. It encompasses two phases:

1) the conceptual development of artefacts and
2) their application in practice.

The application of new artefacts to practice is understood as a social action, which leads to modifications of the real world affecting people and organisations (Mead 1913). Thus, the researcher is often directly involved into pragmatist research. These fundamental assumptions – reflecting the practical and social nature of the much later developed learning paradigm of constructionism – are purported to pragmatist research methodologies such as design-oriented research, action research, or mixed methods research (Baskerville and Myers 2004; Johnson and Onwuegbuzie 2004).

Design science research as well as DBR are described as methods, which solve problems within their natural environment by designing solutions (Simon 1996). Design-oriented research, therefore, shares its roots with Action Research. However, it does not just focus on the needs of a specific problem but aims for the generalisation of the solution to a class of general problems and theories (Barab and Squire 2004).

1.2.1 Design Science Research in Information Systems

Design science as a research approach in ISs emerged with the seminal article by Hevner et al. (2004) combining earlier streams of research. Figure 1 shows the information systems research framework (Hevner et al. 2004, p. 80) defining ISs research as devoted to rigour and relevance. While scientific rigour is ascertained by embedding research into related theoretical foundations (e.g. theories, frameworks, instruments, etc.) and adhering to scientific methodologies (e.g. data analysis techniques, formalisms, measures, etc.), relevance stems from people, organisations, and technology dealing with the problem in practice. In other words, rigour builds upon the scientific body of knowledge applying it to the research problem, while relevance is grounded into business needs formulated by the environment. IS research aims to develop and justify theories respectively build and evaluate artefacts encompassing instantiations, methods, models, or constructs (Gregor and Hevner 2013) in an iterative way. In the end, ISs research serves a twofold aim as it

1) extends the knowledge base creating new foundations and methodologies and
2) must be applicable to the environment improving practice.

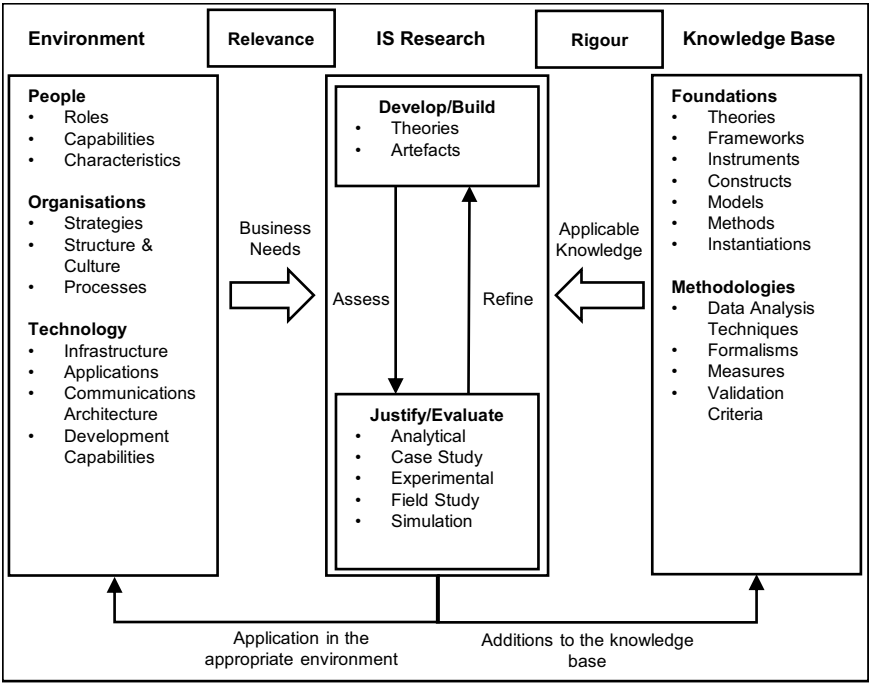

Figure 1 Information Systems Research Framework (Hevner et al. 2004, p. 80)

The ISs research framework allows numerous research methodologies among them behavioural science, focusing on the development and justification of theories, as well as design science, focusing on building and evaluating artefacts. While behavioural science is purported to exhibit high levels of rigour often relying on quantitative methods and statistical analyses, it is criticised because of its lack of relevance being disconnected to practice (Baskerville and Pries-Heje 2010; Hevner et al. 2004). In contrast, design science research aims to provide relevance as well as rigour referring to people, organisations, and technology describing the problem environment as well as foundations and methodologies from the scientific knowledge base. Business needs and scientific knowledge are embodied into the building and evaluation of artefacts, eventually feeding back business applications and additions to the knowledge base. However, design science research is also criticised for low levels of scientific rigour, since

many publications focus on instantiations as artefacts analysing software prototypes without abstraction (Gregor and Hevner 2013). However, from its seminal publication in 2004 until today, the applications of design science research have been specified further including detailed methods to clarify the goals of a design science research project (ibid.), structured process models and frameworks to rigorously build (Baskerville and Pries-Heje 2010) and evaluate (Venable et al. 2016) artefacts. Therefore, design science research can be regarded as an acknowledged method of ISs research today.

1.2.2 Design-Based Research in the Learning Sciences

In the learning sciences, a similar stream of research emerged proposing so-called design experiments as a counterpart to behavioural research combining previous approaches to the research methodology of DBR (Collins 1992; Brown 1992). The rediscovery of John Dewey's works on pragmatism (2013) and constructivist thinking (1997) led to a combination of conceptual research and application to the practice of teaching and learning. DBR aims to help learners as well as teachers improving their practices. DBR focuses on six main aspects (Anderson and Shattuck 2012):

1) the design or significant modification of a learning intervention;
2) its implementation within a situated real-life context;
3) its evaluation using mixed methods;
4) continuous improvement of design principles;
5) iterative improvement;
6) joint work between researchers and practitioners.

DBR puts the form of instruction under focus within a realistic context. In contrast to controlled laboratory experiments that are employed in behavioural science, modifications of real learning interventions can be assessed over a long duration (e.g. a whole school year or semester) providing extensive potential for investigation. DBR provides rich insights not only into learning outcomes, but a large plethora of contextual, social, and technological variables including the process of designing and evaluating the learning intervention itself (Barab 2006; Brown 1992). DBR has, therefore, been described to be particularly useful for the investigation of e-learning or blended learning interventions (Wang and Hannafin 2005). However,

DBR faces similar criticism as design science research regarding methodological rigour, therefore, rigour must be provided by a strong foundation of the problem under investigation within theory and design (Confrey 2006). The learning intervention must be conducted adequately, aiming towards an ethically sound improvement of the identified problem. Furthermore, deducted claims must be justifiable with respect to the underlying theory and data as well as relevant and feasible for practitioners. Overall, DBR mostly follows the same assumptions and goals as design science research, applying them to the learning sciences. Compared to design science research, however, DBR has inspired less publications and therefore received significantly less attention in research and practice (Anderson and Shattuck 2012).

1.3 Synthesis and Resulting Approach

The present thesis combines design science in ISs and DBR in the learning sciences to answer the formulated research questions. Such an approach is necessary for a meaningful evaluation of self-regulated personalisation as it is performed by the learners together with peers and lecturers based on their preferences, experience, and context. Such situations can hardly be created in a laboratory experiment, albeit requiring large compromises regarding the richness of the data gathered. Furthermore, the chosen approach emphasises the relevance of the research regarding the improvement of higher education using recent learning methods, e-learning technology and the direct connection between higher education and research at universities. Therefore, the research questions are answered sequentially.

1) In an explorative stage, personalised learning is assessed conducting a laboratory experiment comparing two learning interventions – one focusing on self-regulated learning and one focusing on lecturer-centred learning (chapter 2). The study itself comprises of a build and evaluate phase, firstly creating personalised trainings, secondly evaluating them empirically regarding learning outcomes. Chapter 3 builds upon the results of the previous chapter theorising on the PLF. The result of stage 1 represents the PLF as a conceptual model of self-regulated personalised learning.
2) In a confirmative stage the PLF is evaluated within a realistic environment. Therefore, a university course is transformed into a

self-regulated personalised flipped classroom using the PLF as a basis. An explanatory design theory is developed deriving general requirements regarding such a course from the literature leading to general course components which are eventually implemented (Baskerville and Pries-Heje 2010). The resulting course design (chapter 4) is implemented and evaluated over a complete semester to generate findings about the course itself as well as the underlying framework. Within this evaluation a mixed-methods approach is chosen, combining qualitative observations and interviews complemented with quantitative surveys to achieve a holistic picture, which is described in chapter 5 (Johnson and Onwuegbuzie 2004; Venkatesh et al. 2013). The result of stage 2, therefore, is a generalisable approach for designing and evaluating self-regulated personalised learning courses, which is not only bound to the course transformed within this thesis. While the exploration of the problem domain and the conceptualisation on the PLF provide an artificial and formative evaluation relying on rigour provided by empirical research and literature, the confirmative stage aims for a naturalistic and summative evaluation of the whole concept (Venable et al. 2016).

Gregor and Hevner (2013) present three types of design science contributions from situated implementations of an artefact over nascent design theories to well-developed design theories. While situated implementations focus on specific and limited scenarios providing less mature knowledge, well-developed design theories provide abstract, complete, and mature knowledge about a phenomenon. This thesis aims for a nascent design theory of self-regulated personalised blended learning including operational knowledge on design principles and architectures as well as the situated implementation of the framework itself. The targeted contribution of this work can be categorised according to the dimensions of solution maturity and application domain maturity (Gregor and Hevner 2013). If maturity is high on both dimensions, the contribution lies in the application of known solutions to known problems, which is not a scientific knowledge contribution (cf. Figure 2). If new solutions are developed for known problems, this is categorised as an improvement, whereas the extension of known solutions to new problems is called an exaptation – both presenting valuable research opportunities. Eventually, low solution maturity paired

with low application domain maturity leads to an invention combining new solutions and new problems, eventually describing a valuable but complex research opportunity.

Since there is already a large number of publications dealing with the topic of personalising learning the application domain maturity can be considered to be high. The presented solution, using a self-regulated approach in combination with blended learning is rather new, characterising solution maturity to be low. Hence, the present work aims to contribute an improvement to self-regulated personalised learning providing new solutions (i.e. PLF) to the known problem of personalised learning.

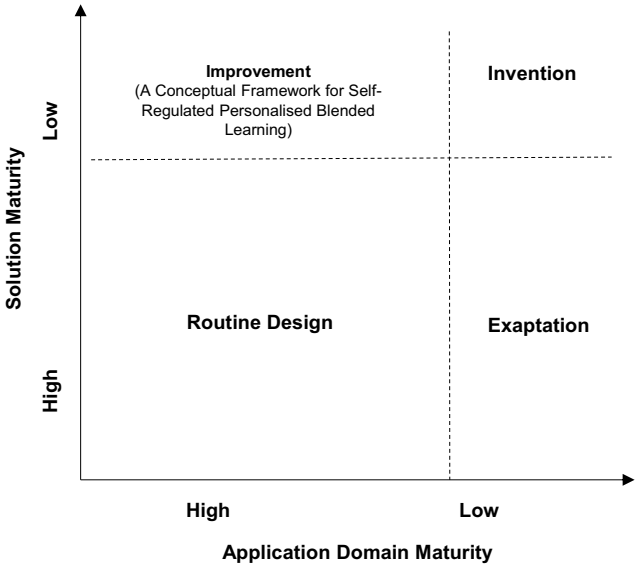

Figure 2 Contributions of Design Science Research (adapted from Gregor and Hevner 2013, p. 345)

The structure of this thesis is outlined in Figure 3. Chapter 1 introduces the topic and describes the selected research methodology following a design-oriented approach. Chapter 2 presents a study on personalised learning investigating the matching of learning styles and teaching methods showing that learning styles are not the only relevant factor for personalised learning. Chapter 3 builds on these findings, presenting a conceptual framework for task and tool personalisation. Based on the theory of cognitive fit, the framework aims to define all relevant factors of personalised learning and their relationships. This framework is consequently implemented in chapters 4 and 5. While chapter 4 describes the design of a university course implementing the PLF, chapter 5 focuses on an evaluation concept aiming to generalise the findings of this work. Chapter 6 discusses findings of the presented studies in a holistic manner, also describing limitations of the chosen approach, concluding this work summarising its contributions and presenting implications for research and practice as well as potential for future research.

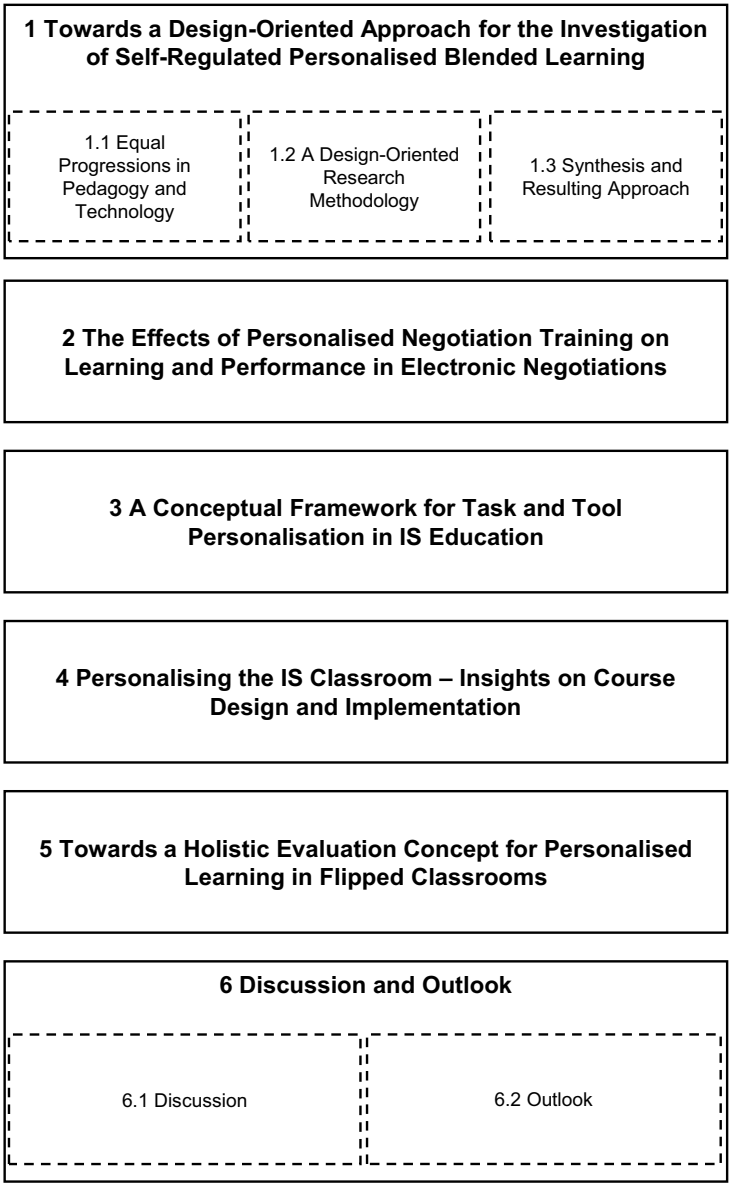

Figure 3 Structure of the Thesis