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A Framework for Designing Learning Management Systems for Thesis Projects

Colombage Ranil Peiris[1], Sirkku Männikkö Barbutiu[2] & Henrik Hansson[3]

[1]PhD Student, Department of Computer and Systems Sciences,
Stockholm University, Sweden
Senior Lecturer, Department of Information Technology,
University of Sri Jayewardenepura, Sri Lanka
cranil@sjp.ac.lk

[2]Associate Professor, Department of Computer and Systems Sciences,
Stockholm University, Sweden
sirkku@dsv.su.se

[3]Professor, Department of Computer and Systems Sciences,
Stockholm University, Sweden
henrik.hansson@dsv.su.se

Abstract: *This study intended to develop a framework for designing a Learning Management System for supporting thesis projects. A model named 'Explanatory Design Theory' was followed as a methodology to identify the component of the proposed framework. The following four steps were followed: 1.) Identification of kernel theories, 2) Analysis of kernel theories and identification of meta-requirements, 3) Formulation of design components based on meta-requirements, 4) Formulation of testable hypotheses. Developing the designing explanatory design theory was a four-step process; each step was crucial and decisive. The first step involved identifying kernel theories related to thesis supervision. These were Zone of Proximal Development, Scaffolding, and Self-regulation. Secondly, meta-requirements were determined based on kernel theories, and it was discovered that enhancing the student-supervisor interaction and supporting students' self-regulation processes were key meta-requirements, based on which, the components of FLMSTP were identified at the third step, and labelled as Initiation, Planning, Implementation, and Completion. The final step was the setting of hypotheses formulated to refine kernel theories and evaluate the accuracy of meta-requirements and the usefulness of the components.*

Keywords: *Design theory, Design practise, User-centred design, Systems design, Thesis supervision systems*

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1. Introduction

Students enrolled in undergraduate degree programmes learn mainly from common course works. In addition to course works, students must conduct an independent research project (thesis project) that entails unique planning, more learner autonomy, and responsibility. Completing an undergraduate thesis project involves student-supervisor interaction, higher motivation, and self-regulation skills. However, previous studies suggest that the lack of the above-listed qualities is a common problem in undergraduate thesis projects (Peiris et al., 2018). Undoubtedly, these problems and shortcomings negatively affect the quality and efficiency of the thesis process.

Previous studies suggest that one of the efficient approaches to address the above-discussed issues is Information and Communication Technologies (ICT), which helps to enhance interactions (Augustsson & Jaldemark, 2014; Jaldemark, 2012), students' motivation, and self-regulation (Dabbagh & Kitsantas, 2005; Ge, 2013) in thesis project activities. As a pedagogy, learning through thesis projects shares assumptions of social constructivist learning theories, and research highlights ICT as a valuable tool supporting constructivist learning environments. However, surprisingly, it is observed that the use of ICT is rare in undergraduate thesis learning activities. The author interviewed a total of five thesis project administrators, including two from other Sri Lankan universities, one from a Mozambican university, one from a Rwandan university, and one from a Bangladeshi university. All these universities have implemented a Moodle-based LMS for other courses, except thesis project supervision. The interviews revealed that they are not aware of the potential use of web-based technologies for thesis projects. Literature and professional experience altogether disclose that the use of ICT for thesis projects is limited since, 1) there is a lack of specifically designed information system to support thesis project learning activities using ICT, and 2) there is a lack of shared knowledge of designing information systems to support the thesis project learning activities using ICT. Information systems that utilise ICT to support general learning activities are Learning Management Systems (LMS) (Nafsaniath et al., 2015). Therefore we used the term “Learning Management Systems for Thesis projects” (LMSTP) for ICT-based information systems designed to support the thesis project learning activities.

Several studies have been conducted on designing and using generic LMS for undergraduate thesis projects, but the limitations involved inhibiting them from being used as LMSTP. General learning management systems are applicable here (Nozal et al., 2013), but their compatibility is limited, as they have been designed to support coursework learning activities. Personal Learning Environment (PLE) can help create a personalised learning environment (Sharafuddin et al., 2018), but there is a lack of tools needed to be used as an LMSTP. Similarly, the tailor-made systems (Hansson et al., 2010), specifically designed to meet the requirements of a specific department or programme, have a lack of focus on the general thesis processes. Similarly, in general, only limited studies focus on designing LMSTP, referring to assumptions of learning theories applicable to learning activities of the thesis projects.

Therefore, a study of designing LMSTP entails paying attention to major theoretical assumptions, and the outcome of the study can be used to develop LMSTP or upgrade general LMS. Therefore, this study intends to develop a framework for designing learning management systems for supporting thesis projects; and we have prepared two research questions based on the purpose and knowledge gap.

Research question 1). What are the common requirements of learning management systems for the thesis process?

Research question 2). What components should be included to meet the identified common requirements?

2. Literature Review

2.1 Explanatory Design Theory (EDT)

The quest to answer the research questions necessitates developing a framework for designing a Learning Management System (LMS). As LMS is a type of information system, information system design theories were studied to identify a suitable model for the framework development process. Although, the literature on information systems design theory is broad and plentiful, a complete agreement about the characteristics and components of design theories is difficult to come across (Baskerville & Pries-Heje, 2010). Walls et al. (1992) introduced a model with two aspects: the first aspect deals with the product of the design, and the second, the design process. Figure 1a illustrates the dualist model proposed to cover both the design process and the product of such a design process.

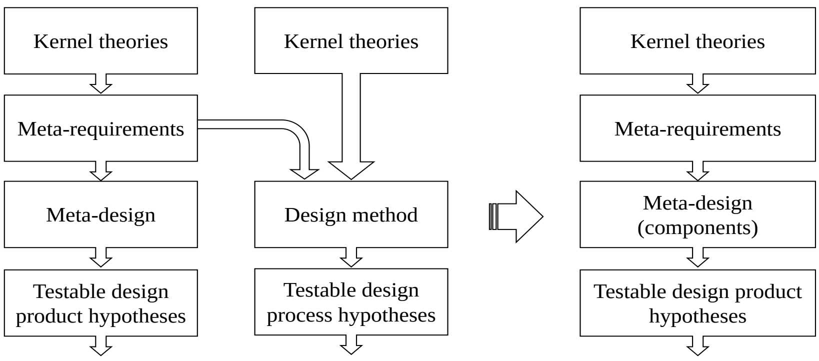

Figure 1a. Dualist view: design product and process (Walls, Widmeyer, & El Sawy, 1992)

Figure 1b. Components of an explanatory design theory

Figure 1. A theoretical framework for designing an explanatory design theory

Baskerville and Pries-Heje (2010) criticise the dualist perspective, arguing that it appears to be rather elaborate and overly complicated. They suggest separating the dualistic assumption, proposing two types of design theories; the first is the *design practice theory*, and the second *design product theory*. Design practice theory prescribes how to practically design something, while the design product theory explains the principles related to the requirements of an artefact. The design product theory is consistent with the definitions of functional and teleological scientific explanations and will introduce the type of design theory as Explanatory Design Theory (EDT). They argue that only two elements are fundamentally necessary for a complete EDT: *requirements (meta-requirements)* and *solution components (meta-design)*. They define EDT as a "*general design solution to a class of problems that relates a set of general components to a set of general requirements"* (Baskerville & Pries-Heje, 2010) and they consider kernel theories testable hypotheses are optional. However, a logical approach is required to identify the meta-requirements of a class of problems. When applicable, kernel theories provide a theoretical base that can be used to identify meta-requirements; otherwise, the study will bring in a design for a specific situation, developing a solution for a specific problem and a practice of building IT artefacts. Furthermore, they consider testable hypotheses as optional components. However, testable hypotheses serve well to validate the theory and enhance the rigour of the research process. Therefore, testable hypotheses are included in the framework as a component. According to the modified theoretical framework (Figure 1b), the explanatory design theory will be built throught the following four steps:

1. Identification of kernel theories
2. Analysis of kernel theories and identification of meta-requirements
3. Formulation of design components based on meta-requirements
4. Formulation of testable hypotheses

Although the name of the output of the selected method is explanatory design theory, the focus of the present study is to develop a framework for designing LMS for thesis projects. Therefore, proposed framework is named Framework for Designing Learning Management Systems for Thesis Projects (FLMSTP). The full name of the framework is too long, and the acronym (FLMSTP) may not fit with the context. Therefore, in this paper, the term "Framework" is used instead of using the acronym FLMSTP or the model's full name.

2.2 Identifying kernel theories for the thesis process

Kernel theories are frequently discussed in design science research, but the concept of kernel theories is underspecified (Duick & Baskin, 2012). The previous studies consider any natural or social science theory as a kernel theory if the specified theory can be used to develop an artefact. Although the term "theory" is used technically, kernel theories vary from formal theories, models, concepts, hidden assumptions, and beliefs (Duick & Baskin, 2012).

2.3.1 Zone of Proximal Development (ZPD)

Previous studies unravel that the thesis supervision pedagogy shares assumptions of constructivist learning theories (Kardash, 2000). Drawing on Vygotsky's (1980) sociocultural theory which serves as the foundation for the constructivist approach to learning, the study aims at investigating the thesis process as a form of learning, in which, social, cultural, and historical factors play a crucial role, and mediation by those more capable is pivotal (Kretchmar, 2013). The central idea of the sociocultural theory of learning is that students construct knowledge through interactions. The ZPD concepts suggest that students need support (Scaffolding) from teachers (or peers) to bridge the gap between their current abilities and the intended goal (Barak & Carla, 1992; Wilson & Devereux, 2014). At this point, Vygotsky perceives mediation by experts or capable peers as an essential component of the constructivist learning environment. Thus, ZPD and Scaffolding should be included as related kernel theories.

2.4.2 Self-regulation Theory of Learning

Self-regulated learning refers to the processes through which the learners personally activate and sustain cognitions, affects, and behaviours systematically oriented towards attaining personal goals, with or without seeking the help of peers, coaches, and teachers (Zimmerman & Schunk, 2011). Several distinct models have been developed to explain the self-regulation process, but many have overlapping concepts (Carneiro et al., 2011, pp. 4–17). According to Bandura's social cognitive perspective, Cassidy (2011, p. 991) argues that *"self-regulated learning occurs as a result of reciprocal causation between three influence processes: personal processes such as perceptions of ability (e.g., academic self-efficacy) and self-motivation (e.g., goals); the learning environment, including task demands and encouragement from teachers; and individual behaviour, such as performance outcomes (e.g., previous marks/grades)."* Based on this view, Zimmerman (1989) discusses a triadic model of Bandura's work (Figure 2), incorporating social learning constructs and assumptions. The essence of Bandura's triadic formulation (as cited in Zimmerman, 1989, p. 2) is that the behaviour is a product of both self-generated and external sources.

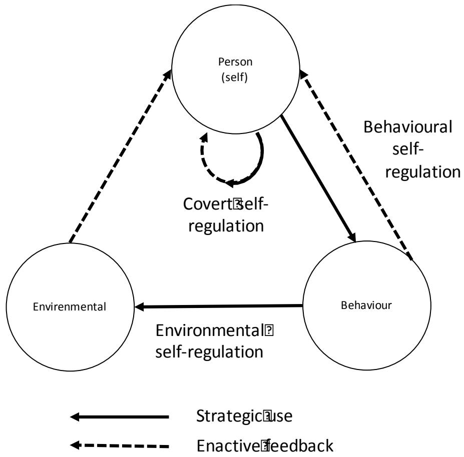

Figure 2. A triadic analysis of self-regulated learning

According to this model, self-regulated learning is not determined merely by personal processes; these processes are assumed to be influenced by environmental and behavioural events in a reciprocal fashion. In addition to the triadic model, the study follows Zimmerman's model, based on the social learning psychologist's view (2002, p. 67), since it explains a process that provides a framework applicable to the thesis process. Figure 3 explains the structure of the self-regulatory processes, referring to three cyclical phases applicable to the thesis project supervision. The model emphasises the importance of design components in incorporating the supervisor's and peer's interactions in thesis learning management systems.

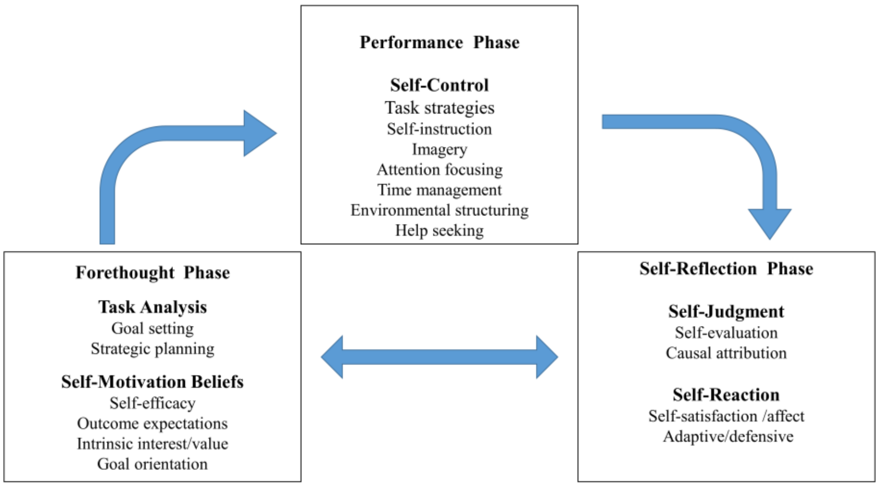

Figure 3. Phases and sub-processes of self-regulation

The model depicted in Figure 3 can be applied to an individual learning activity and the whole thesis project. The forethought phase refers to processes occurring before the learning activity. The performance phase refers to the implementation, and self-reflection refers to the phase that follows each learning effort. This model emphasises a set of self-regulation strategies concerning meta-cognitive perspectives. These two models have been used to identify the components required in a Learning Management System for thesis projects to stimulate students' self-regulation processes.

3. Methodology

Although the term "theory" is used, the outcome of this study is not a full theory. The findings will be used as a framework that can be used as a guide for designing LMS for thesis projects. The components of the framework would identify following the four-step process, as indicated in Figure 1b. The evaluation of the components will be conducted through a survey and demonstrations using the SciPro and Moodle features. Moodle (Sulisworo et al., 2016) is an Open-Source Learning Management System, and it has been specifically designed to support generally large size classroom learning and teaching. However, many tools can be used to demonstrate some of the components of the framework. SciPro (Peiris & Hansson, 2017) is a tailor-made LMS to support the Department of Computer and Systems Sciences thesis projects. This paper is a part of a PhD thesis and a few preliminary studies conducted. A management faculty in a Sri Lank an public university was selected as the research context. A case study was conducted to understand the problems of the thesis projects in that faculty (Peiris et al., 2018). The same context was selected to evaluate the framework. An online survey was conducted with a brief demonstration of the framework, and 52 supervises participated.

3.1 The framework development process

According to the selected model, as illustrated in Figure 1b, an explanatory design theory consists of four components, including kernel theories, meta-requirements, meta-design components, and testable hypotheses. This study analyses the thesis process, concentrating on the empirical evidence, assumptions of kernel theories, and personal experiences of supervisors to identify what components should be included in the framework.

At first, the thesis process was divided into four phases (Figure 4) to simplify the framework development process. The framework was also divided into four modules, and a module covered the requirements of a phase. Therefore, the learning activities of phases were analysed to identify the requirements and subcomponents. The analysis followed the steps given in Figure 1b to identify the subcomponent of a module. The four-step model was repeated four times to develop four modules. The output of the process, the four modules, have been illustrated in Figures 5, 6, 7, and 8. A comprehensive view of the framework including four modules have been illustrated in Figure 9.

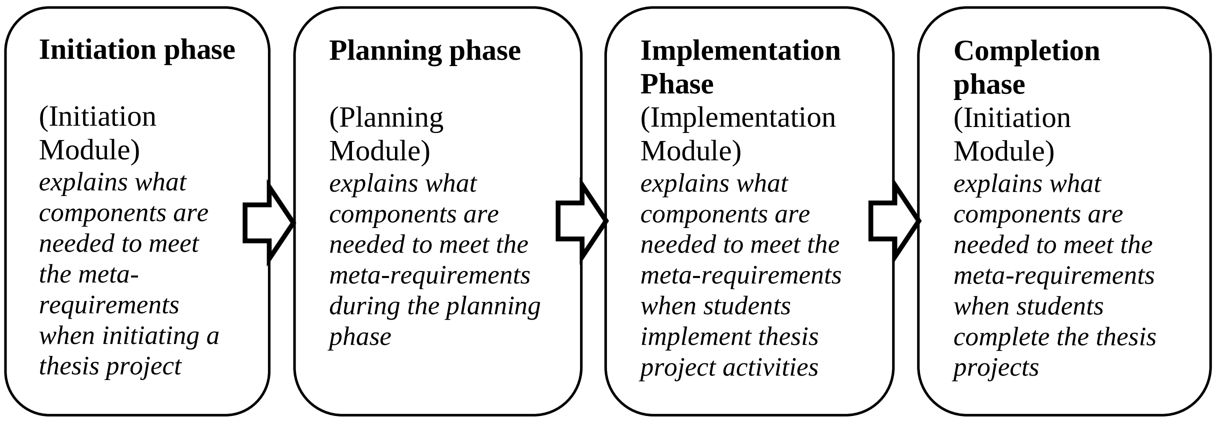

Figure 4. Thesis process, phases, and proposed modules

The analysis process of the initiation module is as follows (this discussion is referred to Figures 5,6,7, and 8). The analysis, at first identifies the related kernel theories (KT) and subsequently the meta-requirements (MR). Next, a set of subcomponents (SC) is formulated to meet the identified meta-requirements. A sub-component includes functions necessary to meet one meta-requirement. At the last step, the study formulates a testable hypothesis to assess the usefulness of the sub-component/s, and they are numbered with the prefix TH. The code numbers represent the relationships between KT, MR, SC and TH. For example, at the end of MR 1, there is KT1 (as a code), inferring that MR 1 is related to KT 1.

3.2 Initiation Module

The initiation module covers the thesis process from the beginning until a thesis project is formally established. Figure 5 presents an overview of the initiation module and functions.

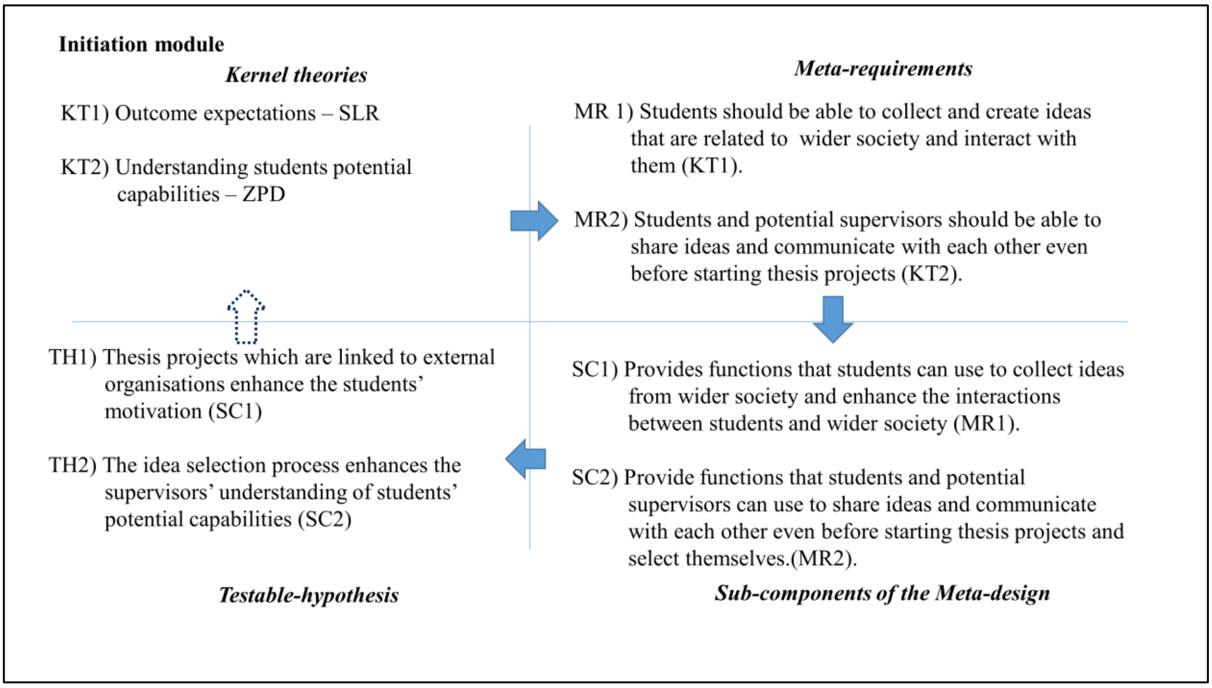

Figure 5. Initiation module and functions

3.2.1 Idea Bank

Previous studies have identified that one of the main problems observed in thesis projects is the lack of students' motivation (Afzal et al., 2010; Peiris et al., 2018; Pintrich, 2003) . Analysis of the related kernel theories has recognised the possibility of the concept of outcome expectation (Zimmerman, 2002, p. 67), being used to enhance students' motivation. Students are motivated to produce a higher outcome if they see the value of such outcomes (Bandura, 1994). Producing a thesis as an outcome requires a higher effort than general courses (Harrison & Whalley, 2008), and if the outcome is only another "grade", it will reduce students' motivation. If the students comprehend that the outcome is valuable, it will enhance their motivation. Generally, the thesis project is scheduled at the last stage of the degree programme, and at which the students are interested in finding job opportunities. Therefore, if the thesis project is related to the industry or real organisational problems – which will eventually contribute to increasing their employability – it will boost the students' outcome expectations. Therefore, linking industry and external organisations as a source of thesis project ideas is a meta-requirement that should be included in the initiation module. To meet that meta-requirement, the LMSTP should have a component that links the thesis projects with external parties such as companies and government institutions. This requirement can be satisfied through a design-component called *Idea Bank*, in which external organisations can also provide ideas that enhance students' outcome expectations. There are interested external parties to collaborate with student research projects, but the main problem is the lack of systematic coordination (Peiris et al., 2013; Wijesinghe et al., 2018). Universities can address the coordination issue, if an LMSTP has a component that supports sharing ideas between external organisations and students who intend to start thesis projects. The study formulated the first hypothesis related to the initiation module; "thesis projects linked to external organisations enhance the students' motivation."

3.2.2 Pre-Communication

Thesis project supervision unofficially starts when students start attempting to select the basic ideas for their thesis projects. An academic individual responsible for thesis projects collects ideas from students and directs students to the relevant supervisors. Thus, supervisors lack a proper understanding of the thesis until they start the thesis project. When applying the concept of ZPD to the thesis project supervision, it is suggested that student-supervisor interaction is necessary from this initial step since it tends to enhance the supervisors' understanding of the students' ZPD. As a result, it is a meta-requirement that an LMSTP should contain a design component that implements interactions between students and potential supervisors in a formal manner. The Idea bank component should have a function that allows students and supervisors to share ideas, and they should be able to communicate when they find an exciting idea to start a thesis project. The study formulated the second hypothesis related to the initiation module: i.e., "idea selection process enhances the supervisors' understanding of the students' potential capabilities."

3.2. Planning Module

The planning module covers how students and supervisors prepare the thesis project plan. Figure 6 presents an overview of the planning module.

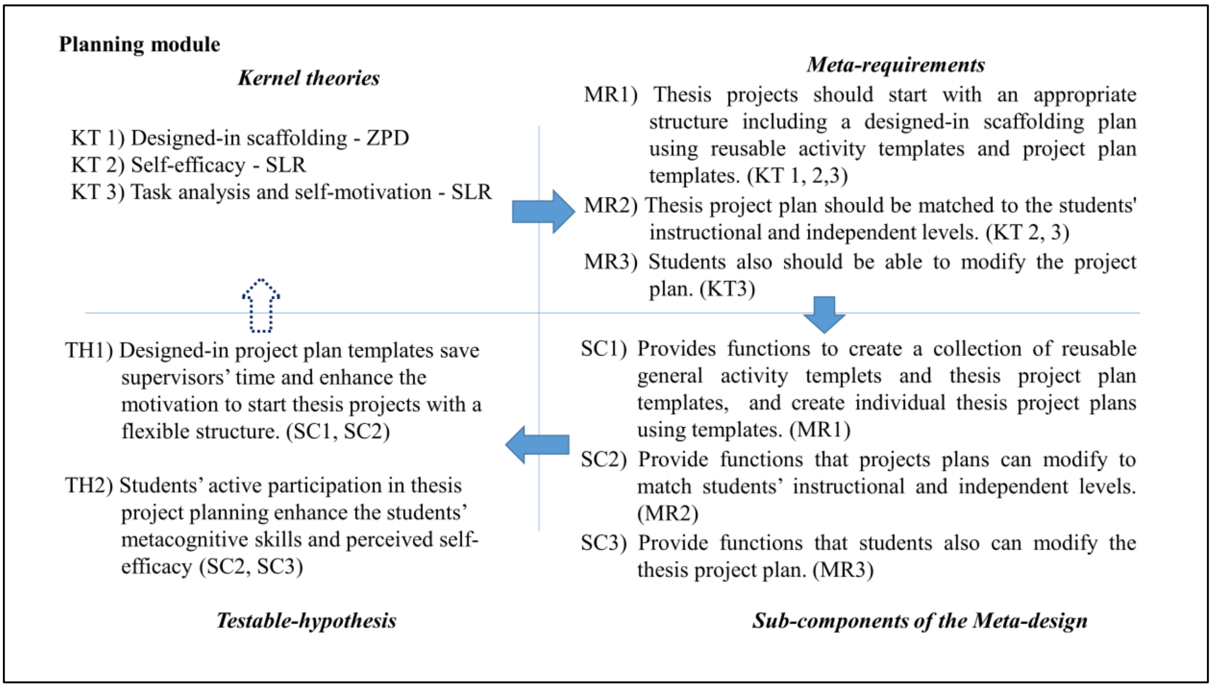

Figure 6. Planning module and functions

3.2.1 Project Plan

According to the ZPD concept, a scaffolding plan is needed to help students reach far into their Zone of Proximal Development. From supervisors' perspectives, preparing a thesis project plan is time-consuming, and novice supervisors may lack experience in preparing a thesis project plan. Scaffolding concepts provide a framework for preparing a thesis project plan that reduces the supervisors' time for planning. Thus, novice supervisors can also use project plans that are already developed by experienced supervisors. Wilson & Devereux (Wilson & Devereux, 2014) highlight that scaffolding enhances students' engagement in highly challenging tasks like thesis projects. The SC1 is the suggested software subcomponent and it should provide a facility to reuse the thesis project plans (as reusable templates).

3.2.2 Unique scaffolding plans

A type of scaffolding, called *designed-in* (Gibbons & Hammond, 2005), suggests planning the supervision, including pre-scheduled scaffolding activities supporting general thesis project activities such as research design, sampling, data collection, data analysis, conclusions (or findings), and report writing. The scaffolding plan should match the students' knowledge and skill levels.

3.2.3 Collaborative planning

The study has also identified a few meta-requirements to be met by the planning module related to *task analysis* and *self-motivation sub-processors* of the forethought phase (Zimmerman, 2002). The task analysis sub-process suggests that the student should participate in the goal-setting of learning activities and planning them. Similarly, previous studies have identified students' participation as a metacognitive self-regulation strategy, and they positively influenced academic performance when they have embedded adequately into learning activities (Delen & Liew, 2016, p. 27). These findings bring a new function to the planning module, i.e., students should be able to plan their learning activities in contrast to general LMS, where teachers set the plan and students follow the plan. This requirement can be met by developing an LMSTP where students can also select and modify the thesis project plan and activities.

3.3 Implementation module

In traditional course works, lecturers prepare a pre-scheduled set of common learning activities, and, according to that schedule, the lecturer meets all the students in a classroom. In contrast, in thesis projects, students are responsible for implementing the related activities by themselves in most cases. Therefore, during the implementation phase of the thesis projects, students require more self-regulation and motivation. SLR provides a theoretical framework to identify meta-requirements from the student's self-regulation and motivation perspectives. The performance phase (sub-processes of self-regulation, Figure 3) provides a framework to identify meta-requirements that the LMSTP system should consider while students implement thesis project activities. A summary of all the sub-components of the implementation module is presented in Figure 7.

3.3.1 Visualising thesis project plan

One of the main problems encountered during the implementation phase is that the students and supervisors meet infrequently, and students engage in thesis project activities alone (Peiris et al., 2018). The limited number of face-to-face meetings is insufficient to understand what type of instructions they need, their independent level, and setting up tasks properly, since students get to solve ill-structured problems. As a result, students tend to face stressful situations, and they may feel incapable of proceeding (Peiris et al., 2018). As an approach to overcome this challenge, students should be able to see the project plan and the supervisor should be able to observe the students' independence level and decide the required level of instructions. Especially, when a supervisor is involved in multiple thesis projects, he/she needs support to organise and retrieve the history of all projects in supervision. Based on the students' performance, supervisors can adjust the learning activities to enhance the students' self-efficacy. Therefore, the LMSTP system should contain a function to provide a comprehensive overview of the thesis projects, so that supervisors can instruct on enhancing the students' self-efficacy beliefs.

Previous studies emphasise that the lack of students' engagement with thesis project activities is one of the main issues. In addition to the visualisation of the project plan, functions are required to enhance the students' attention on thesis activities; each should have a start date and a date of completion to encourage time management. In some instances, students do not feel they are actively engaged in project activities irrespective of the time plan. Due to the heavy workload, supervisors will also not consider this issue until the occurrence of a significant issue. Therefore, LMSTP should include a progress monitoring component that generates and send messages to both students and supervisors. The progress should be monitored based on the thesis project plan.

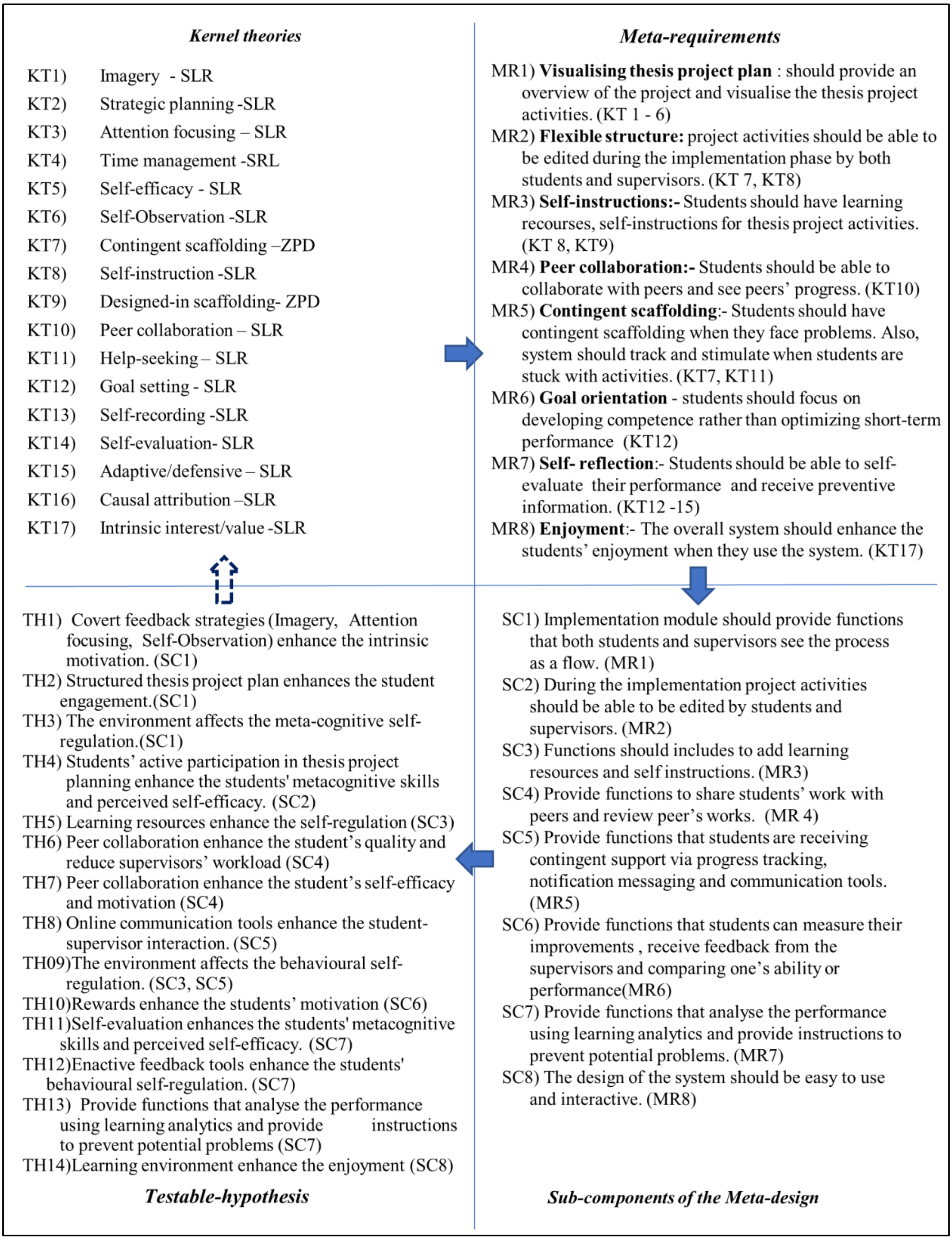

Figure 7. Implementation module

3.3.2 Flexible structure

Thesis projects are related to real-world problems, and the process is dynamic. Therefore, it is a requirement that a thesis project plan should be easily modifiable at the later stages. Similarly, the student Zone of Proximal Development is dynamic, and the project plan needs to be amended to match with the current state of the students' ZPD. Therefore, the LMSTP system should have a function to modify the project plan when necessary.

3.3.3 Self-instructions

Environmental structuring refers to optimising the effectiveness of one's micro-environment (Zimmerman & Cleary, 2009). Each thesis project can be considered as a micro-environment that provides resources for thesis project activities. For instance, students can store related online resources for data collection activities. Self-instruction involves overtly or covertly describing how to proceed to execute a task (Zimmerman & Cleary, 2009). Studies reveal that both lecturers and students contribute to the inconsistency in meeting for consultations, and this also leads to late feedback on submitted work, which affects the research progress (Chabaya et al., 2009). Students will lose their focus if there is a lack of instructions. Initially, this matter can be addressed by embedding instructions into activity templates. In addition to face-to-face meetings with supervisors, which are restricted due to lack of availability, textual and audio-visual instructions can be provided. The LMSTP should be able to provide personalised instructions since students conduct different research projects following different research methodologies. At the same time, instructions can be provided as checklists, including self-assessment questionnaires, to self-assess the completed tasks; primarily, the grading criteria can be used as a checklist that serves as a motivational checklist as well as a template for supervisors to grade the thesis project.

3.3.4 Peer collaboration

Peer collaborations are highlighted as an essential component in the Zone of Proximal Development (Kretchmar, 2013; Vygotsky, 1980; Zimmerman & Cleary, 2009) and SLR has been considered as a strategy that enhances students' motivation. In classroom learning activities, students can collaborate and compare their performance with peers when they have a challenging task. In contrast, in thesis projects, students work individually, and even if students perform well, they may feel a lower self-efficacy since they work individually on the thesis projects. Therefore, LMSTP should include a component to share peers' performance and manage peer learning activities.

3.3.5 Contingent scaffolding

The contingent scaffolding brings another set of requirements when students implement thesis project activities. The contingent scaffolding concept proposes to include *ad-hoc* interactions and support for students. Moreover, students have different life situations (e.g., sickness, death in the family, change of employment) which need to be considered, and in some instances, the situations they face can be unfavourable. Moreover, some thesis activities may be more challenging than expected, and students may need extra support. Therefore, students need contingent scaffolding (Saye & Brush, 2002), and the supervisor needs to continuously diagnose the understanding of a learner and provide timely support based on the learner's responses. To provide contingent support, face-to-face meetings alone are not adequate due to limited availability and practical issues of arranging meetings when students need support. Therefore, asynchronous and synchronous online communication tools should be integrated with the LMSTP for contingent interactions. At the same time, studies have discovered that students do not actively seek help with their academic problems (Cheng et al., 2013), and therefore LMSTP can initiate the help-seeking activity by sending notifications to students and supervisors if the system detects a help-needed instance or event. This feature can be linked with notifications; for example, sending a message to ask for help if students could not complete a task on time.

3.3.6 Goal orientation

Goal orientation refers to students' focus on developing competence rather than optimising short-term performance (Zimmerman & Campillo, 2003). Pintrich (1999, p. 466) discusses three types of goal orientations that are perceived as LMSTP requirements. A mastery goal orientation refers to a concern with learning and mastering the task, and it involves providing self-set standards and self-improvement facilities. Activity templates can provide standards that students can depend on to measure their improvements. An extrinsic orientation focuses on achieving good grades and pleasing others as the primary criterion for judging success. For these requirements, the LMSTP should have options to grade individual activities and provide feedback from the supervisors. The relative ability orientation refers to a concern for comparing one's ability or performance, which means LMSTP should visualise how other students progress in their projects.

3.3.7 Self-reflection

The self-reflection strategies bring requirements to enhance self-evaluation. Zimmerman (2002, p. 68) discusses self-evaluation strategies, two of which are applicable in thesis project supervision; 'comparisons of self-observed performances against the absolute standard of performance' and 'comparing with another person's performance'. The system should track and show how the student follows the project plan as an absolute reflection. Details of how other students complete their thesis activities can appear as another person's performance measurement. An online system can anonymously display how students progress in their thesis projects.

Another form of self-judgment involves causal attribution, which refers to the frequent causes of previous failures (Zimmerman, 2002) in typical thesis project activities; one example is the most frequent errors made by the students during the data collection phase. Supervisors should generate this information in a central place and link to each activity. Similarly, the component should automatically link the most frequent errors to the related activity plan. Self-reaction involves feelings of self-satisfaction and positive effects regarding one's performance. The online portal that visualises students' project plans, how they are being performed, and causes of previous failures can undeniably enhance students' self-satisfaction.

3.3.8 Enjoyment

Zimmerman and Cleary suggest that students' intrinsic interest can be enhanced by referring to or valuing a task based on their enjoyment (Zimmerman & Cleary, 2009), while Yi and Hwang (2003) propose that enjoyment might play an influential role in determining the usefulness perception within the web-based information system context. Therefore, the study suggests concentrating on Lin and Gregor's (2006) six suggestions for encouraging online learning for enjoyment; 1) attractive appearance, 2) increasing interaction with learners, 3) ease of use, 4) asynchronous accessibility, 5) relaxing and short tasks, and 6) provision of applicable hyperlinks integrated with the experts' viewpoints. These suggestions recommend designing the overall system with interactive and attractive user interfaces.

3.4 Completion module

Although students are not professional researchers, they are researching under the guidance of a qualified supervisor. The outcome of the thesis project is the thesis project report, which will be used to grade the students' work. Theses will be stored in university archives and rarely used as a source of knowledge.

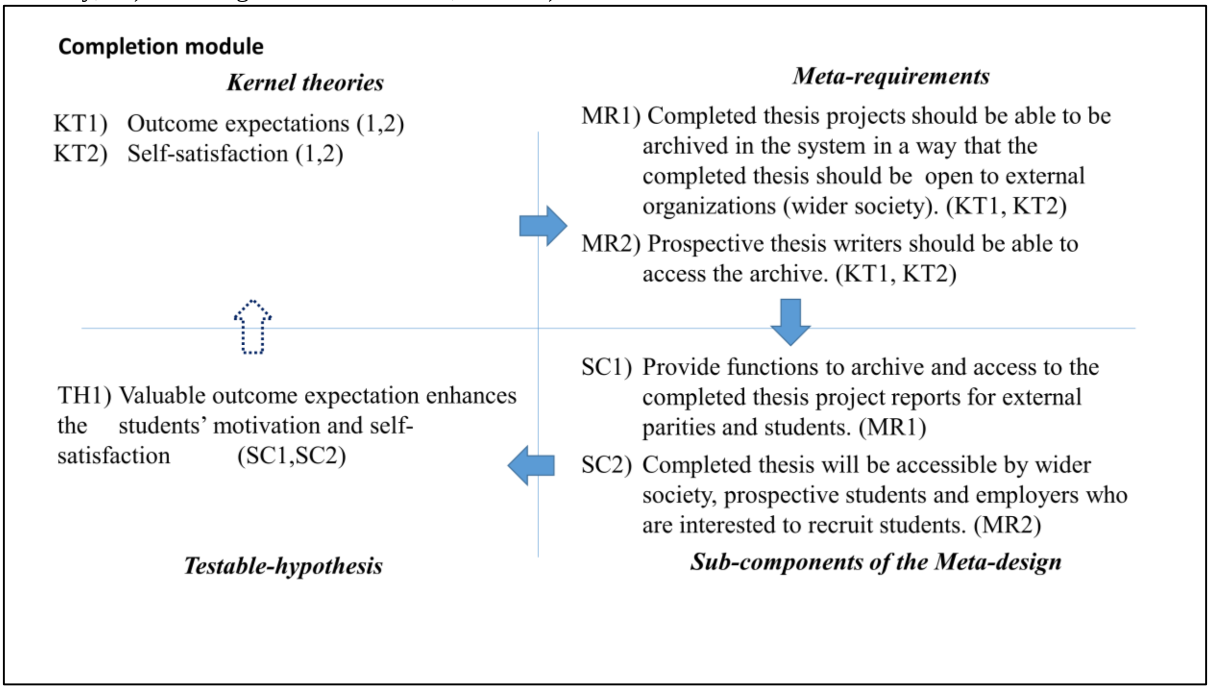

Figure 8. Completion module

3.4.1 Sharing Thesis with Industry/society

As Bandura (1994) suggested, students are motivated to produce a higher outcome if the students see the value of those outcomes. The thesis project report can be used to enhance the students' outcome expectations if they are published as an accessible resource collection for interested parties. At first, students can use their thesis project reports to show their performance to potential employees. This will enhance students' motivation and improve their engagement with thesis project activities since the outcome is a value addition for them.

3.4.2 Sharing with students

If the thesis report is shared in a public portal, other students can access the previous reports. It also enhances student motivation. If students know that their reports are public, they will motivate to produce a quality report. Another advantage is that students can learn from these reports and use them as a source of ideas for new studies.

4. Result and Discussion

The framework for LMS to support thesis projects was created concerning the pedagogical requirements of a constructivist learning environment. The framework should have features to support self-regulation learning and scaffolding. Figure 9 summerise proposed four modules as a framework. Figure 9 illustrates kernel theories of each modules, identied requirements based on those kernel theories and software components to meet the identified requrements. Testable hypothsis did not included in Figure 9 due to the limited space and testable hyphothesis also a part of the proposed framework (refer the testable hyphothasis has given in Figures 5,6,7 and 8).

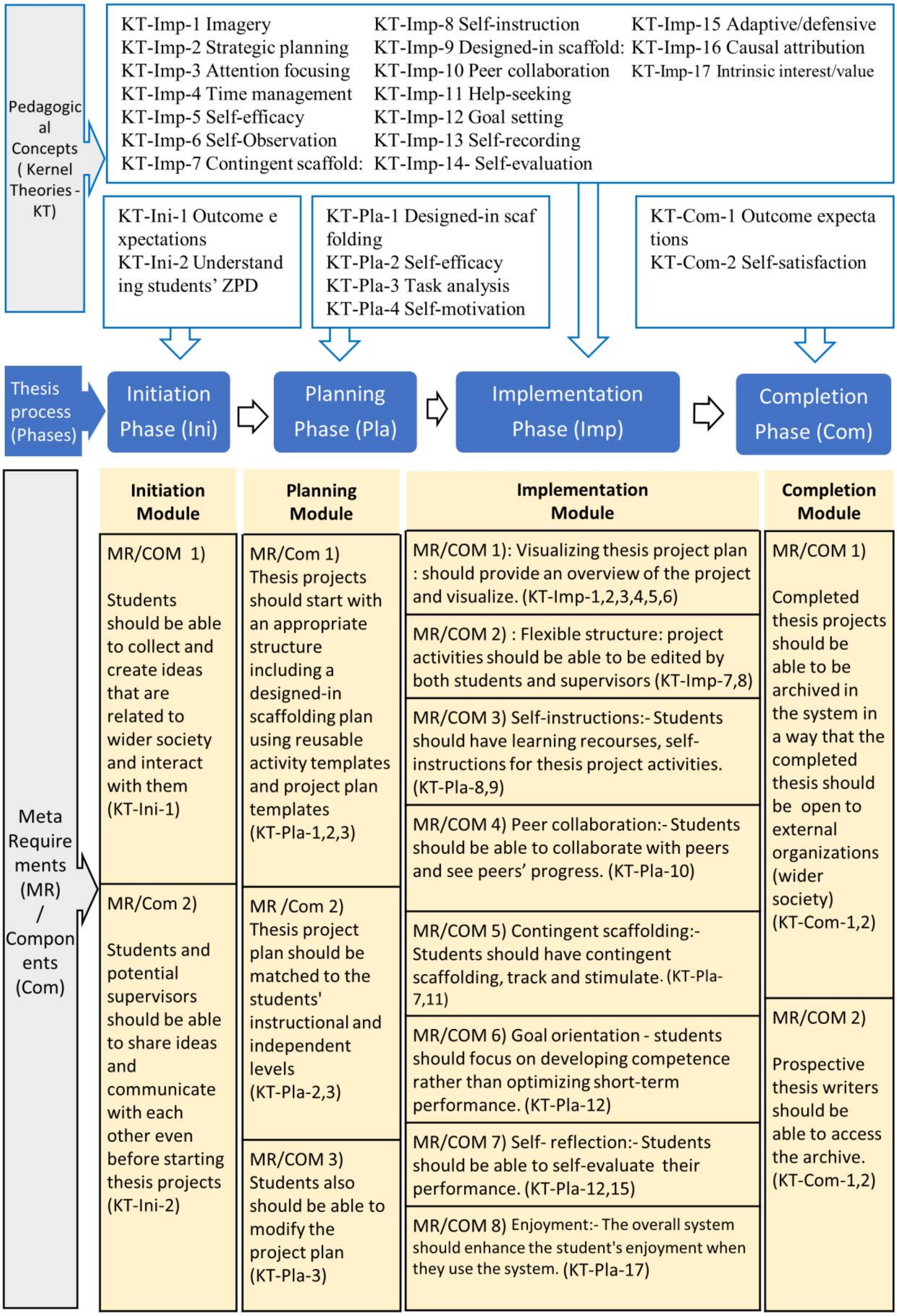

Figure 9. Phases, Modules and Components of the Framework for LMS for Thesis Projects

Proposed components/requirements are identified based on the related learning theories and following the Baskerville & Pries-Heje's (Baskerville & Pries-Heje, 2010) guidelines of explanatory design theory. The components are identified considering the related theoretical concepts of supervision experience as a lecturer and researcher in supervision.

The next step is the evaluation of the proposed framework. March and Smith (1995) define evaluation as “the process of determining how well the artefact performs.” The artefact of this study is the framework, and it suggests including a set of functions of an LMS for supporting thesis projects. Evaluation has different purposes, and one of them is formative evaluation, in which an artefact still under development is evaluated to determine areas for improvement and refinement (Venable et al., 2012). According to the evaluation, the evaluation process is designed as a formative evaluation, and the framework will be refined if necessary. Conceptual design science approach gives freedom to design evaluation, using appropriate empirical evidence or logical proof (Peffers et al., 2007). This study includes both types of evaluation. First, the framework evaluation conducts a survey, and later logically evaluates the utility of components using the findings of previous studies.

The purpose of the survey is to get the participants’ opinion of the impact of proposed features on the thesis projects. Each feature was evaluated from two dimensions, asking two interrelated sub-questions. In the first sub-question, participants requested to rate the impact of the feature as a component of a general LMS for supporting thesis projects (the evaluation should not concern requirements of any context). In the second question, the impact of the same feature was rated as a component of an LMS for supporting thesis projects, designed explicitly for their faculty (their local context). In summary, all proposed features will be evaluated as a feature of a general solution and as a feature of a specific solution developed for a specific context.

Likert scale was used to get answers and they are, Very Positive Impact, Positive Impact, Neutral Impact, Negative Impact, and Very Negative Impact. For statistical calculations, answers were rated from 5 to 1 (from Very positive to very negative). Table 1 represents a summary of data.

Table 1 Summary of Data

	Type of evaluation	*As a General Solution*	*As a Specific Solution*
	Total responses	52	52
	Mean value	*4.1324*	*4.1146*
	Very positive impact + Positive Impact %	91%	91%
Very Positive Impact	5	43%	42%
Positive Impact	4	48%	49%
Neutral Impact	3	9%	8%
Negative Impact	2	0%	1%
Very Negative Impact	1	0%	0%

Findings confirm that more than 91% of participants agree that the framework’s features create a positive or very positive impact as a general solution and a specific solution for the faculty thesis projects. Similarly, both mean values being greater than 4 implies that response evaluated the features are essential at both levels. Similarly, table 1 shows that no one considers at least one feature as not appropriate. About 1% of participants had rated a few features as having a negative impact on thesis projects. Nevertheless, none of the participants rated any feature as having a very negative impact.

Table 2 shows the result, including the components level ratings. In columns 1 and 3, the mean values are greater than 4.1, which implies that participants have selected ‘very positive’ or ‘positive’ as the answer for many components for the general solution (framework) as well as a solution for the in the specific context. Columns 2 and 4 are the percentages of “Very positive impact” and “Positive impact” answers. The highest percentage is 98%, and the lowest is 83%. The values of columns 2 and 4 also imply that most participants rated features as ‘very positive’ or ‘positive’ on thesis projects. Although more details were not included in the Table, it is noted that only 2 participants rated one component as a negative impact feature.

Table 2: Summary of the Result

Module/ Phase	Component/Requirement	Assessment as a General Solution		Assessment as a Specific Solution	
		(1) Mean	(2) Positive %	(3) Mean	(4) Positive %
Initiation Module	MR 1) Students should be able to collect and create ideas related to wider society and interact with them.	4.52	98%	4.38	90%
	MR2) Students and potential supervisors should be able to share ideas and communicate with each other even before thesis projects are started.	4.42	96%	4.37	94%
Planning Module	MR1) Thesis projects should start with an appropriate structure, including a designed-in scaffolding plan using reusable activity templates and project plan templates.	4.40	92%	4.48	96%
	MR2) Thesis project plan should match the student's instructional and independent levels.	4.40	92%	4.37	92%
	MR3) Students also should be able to modify the project plan.	4.37	92%	4.38	96%
Implementation Module	MR1) **Visualising thesis project plan:** should provide an overview of the project and visualise the thesis project activities.	4.44	92%	4.46	96%
	MR2) **Flexible structure:** project activities should be able to be edited during the implementation phase by both the students and supervisors.	4.25	90%	4.19	88%
	MR3) **Self-instructions: -** Students should have learning recourses self-instruction for thesis project activities.	4.38	92%	4.42	94%
	MR4) **Peer collaboration: -** Students should be able to collaborate with peers and see peers' progress.	4.19	83%	4.23	85%
	MR5) **Contingent scaffolding**: - Students should have contingent scaffolding when facing problems. Similarly, the system should track and stimulate when students are stuck with activities.	4.29	87%	4.40	94%
	MR6) **Goal orientation** - students should focus on developing competence rather than optimizing short-term performance	4.27	88%	4.35	90%
	MR7) **Self-reflection**: - Students should be able to self-evaluate their performance and receive preventive information.	4.15	83%	4.19	87%
	MR8) **Enjoyment**: - The overall system should enhance students' enjoyment when they use the system.	4.35	90%	4.27	88%
Completion Module	MR1) Completed thesis projects should be able to be archived in the system so that the completed thesis is open to external organisations (wider society).	4.29	92%	4.12	85%
	MR2) Prospective thesis writers should be able to access the archive.	4.25	90%	4.10	85%

The rest of the evaluation used the logical evaluation method, and the suggested components/features of the proposed framework will be discussed with findings of previous studies.

The study has identified ZPD, scaffolding, and self-regulation as central components in the learning process for thesis projects. These theories form the base for formulating design requirements. Previous research and the studies by the researcher have discussed the problems related to thesis work. As an alternative approach to evaluating the proposed framework for LMSTP, the study analysed the findings of the previous studies.

A frequently reported problem identified that in the thesis process, there is a lack of students' motivation (Afzal et al., 2010; Peiris et al., 2018; Pintrich, 2003) . Ning and Downing (2010) have observed that students' self-regulation predicts their subsequent motivation. According to the self-regulation learning theories, students' motivation is related to the level of students' outcome expectations and self-efficacy beliefs. In the proposed design framework, the initiation and profiling module includes components that enhance students' outcome expectations, hopefully increasing their motivation.

Moreover, students have problems with the time management, planning of their studies, coping with the workload, and organising work (Brew & Jewell, 2012, p. 53; Harrison & Whalley, 2008, p. 414; Todd et al., 2004, p. 342; Wenderholm, 2004, p. 74) . These issues are related to self-regulation learning. The implementation modules provide functions to support students' self-regulation during the thesis project. In general, supervisors at the undergraduate level who supervise many students should guide students to prepare individual thesis project plans. Preparing a project plan is time-consuming; many students start thesis projects without an adequately prepared project plan. The planning module addresses this issue and motivates supervisors to start with individual thesis project plans since they can easily create thesis project plans using reusable thesis project plan templates.

Another common issue is that students feel they lack knowledge in research works (Wenderholm, 2004, p. 74). The thesis project plan can be used as a scaffolding strategy, and the supervisor can provide pre-determined resources that match students' knowledge level (ZPD).

Many studies highlight the student-supervisor interaction as a critical success factor of a thesis project, and the lack of proper student-supervisor interaction is a significant problem in thesis projects (Christie & Jurado, 2013; Peiris et al., 2018; 1995 as cited in Perera, 2014, p. 98). One of the main reasons for the lack of interaction is face-to-face meetings, even when students need *ad-hoc* support. Besides, face-to-face meetings are not always effective, particularly when students need only a small clarification. Email can help with ad-hoc interactions, but users need extra effort to track previous discussions. The proposed discussion forum and help-seeking components provide a formal communication channel where both students and supervisors can easily access and go through previous discussions.

Previous studies reveal that some students prioritise their activities (such as examinations and assignments in other courses) where they have strict deadlines, and may (temporarily) not be involved. As a result, in such instances, students need to track previous activities before they re-start with the project. Similarly, supervisors are busy with other activities, and they also may need a mechanism to remember the history of thesis projects; otherwise, they may give conflicting advice. The project overview helps both students and supervisors quickly return to the thesis project, since the project overview include all the previous activities, discussions, and shared documents as an archive.

Peer collaborations have been considered as a strategy that enhances students' motivation (Baker et al., 2014) and the quality of thesis projects (Aghaee & Hansson, 2013). Students feel isolated since many undergraduate programmes offer thesis projects as individual work. Similarly, social constructivist learning theories consider peer collaboration a vital component of learning. It is challenging to introduce peer collaborations into thesis projects, as students do not meet each other. Using online collaboration tools, the proposed design framework provides functions to overcome the barriers that prevent peer collaboration in thesis projects.

It is interesting to mention that the present study found previous studies mainly highlighting student-related issues as the primary problems in thesis projects. Occasionally, students may have grievances against supervisors because of their busy schedules and ignorance. However, students do not openly discuss or complain due to cultural habits (Peiris et al., 2018), and as a result, they delay thesis projects due to supervisor-related issues. The proposed, designed framework enhances the transparency of the thesis process, and it indirectly motivates supervisors to follow standards in the supervisory process. The study argues that the use of a transparent system will address those issues, in addition to supporting pedagogical assumptions.

5. Conclusion and Recommendations

The core pedagogical practices in undergraduate thesis projects are designed in a way that students should construct knowledge through social interactions. This core principle is in alignment with Vygotsky's social constructivist learning theory. Therefore, the undergraduate thesis process benefits if concepts from this theory, such as the Zone of Proximal Development and scaffolding are considered. A supportive learning environment should aid these aspects. In thesis projects students have autonomy and need to self-regulate their activities. If the students lack self-regulation skills, the thesis project will be a tremendous challenge and they may not be able to complete it. Therefore, self-regulated learning is considered another important concept that should be considered when designing a learning management system to support the thesis projects.

This question was answered by proposing a framework that provides design principles for learning management systems to support undergraduate thesis projects. The framework suggests the sociocultural constructivism theory of learning as the base theory for designing a learning management system for thesis projects. Furthermore, the framework suggests designing the structure of the learning management system with four modules that represent the four phases of the thesis process: 1) initiation, 2) planning, 3) implementation, and 4) completion. The initiation and completion modules provide guidelines to enhance the students' outcome expectations, creating benefits for key stakeholders, i.e., the students and supervisors, universities, industries, and society. The planning module provides design principles that encourage supervisors to start thesis projects with properly designed thesis project plans, including scaffolding tools that support students to reach their potential. The implementation module includes design principles to enhance the student-supervisor interaction and students' self-regulation processes.

Limitations and future research

This study suggests designing a framework to develop information systems to support undergraduate thesis projects. One of the limitations of this study is its focus being limited to identifying the meta-requirements and meta-components concerning the students' and supervisors' perspectives. Thesis course administrators also get involved in the thesis process for administering the process, but this study does not investigate the administrators' requirements. Therefore, we suggest conducting a study of the design process of the LMSTP, including the administrators' requirements. Furthermore, this study is limited to the design component, and hence a different study should focus on the design process. Further, this study builds only an EDT, and it does not evaluate the hypothesis, therefore, the researcher encourages studies to test the proposed testable hypothesis and modify the related kernel theories, meta-requirements, and design-components to consolidate the suggested design. Although the result suggests a design framework, all solutions cannot be found in one, and the suggested design components should match the contextual needs. Therefore, another limitation of this study is that it mainly focuses on thesis projects based on students' field works. However, in some thesis projects, students conduct experiments or develop artefacts in laboratories following structured methods. Therefore, the study suggests the need for similar studies on well-structured undergraduate thesis projects to compare the findings of this study.

6. References

Afzal, H., Ali, I., Aslam Khan, M., & Hamid, K. (2010). A Study of University Students' Motivation and Its Relationship with Their Academic Performance. *International Journal of Business and Management*, *5*(4), 80–88. https://doi.org/10.5539/ijbm.v5n4p80

Aghaee, N., & Hansson, H. (2013). Peer Portal: Quality enhancement in thesis writing using self-managed peer review on a mass scale. *The International Review of Research in Open and Distributed Learning*, *14*(1), 186–203. https://doi.org/10.19173/irrodl.v14i1.1394

Augustsson, G., & Jaldemark, J. (2014). Online supervision: A theory of supervisors' strategic communicative influence on student dissertations. *Higher Education*, *67*(1), 19–33. https://doi.org/10.1007/s10734-013-9638-4

Baker, M. J., Cluett, E., Ireland, L., Reading, S., & Rourke, S. (2014). Supervising undergraduate research: A collective approach utilising groupwork and peer support. *Nurse Education Today*, *34*(4), 637–642. https://doi.org/10.1016/j.nedt.2013.05.006

Bandura, A. (1994). Self-Efficacy. *Encyclopedia of Human Behavior*, *4*(1994), 71–81. https://doi.org/10.1002/9780470479216.corpsy0836

Barak, R., & Carla, M. (1992). The use of scaffolding in higher education.pdf. *Educational Leadership*, *49*(7), 26–33.

Baskerville, R., & Pries-Heje, J. (2010). Explanatory Design Theory. *Business & Information Systems Engineering*, *2*(5), 271–282. https://doi.org/10.1007/s12599-010-0118-4

Brew, A., & Jewell, E. (2012). Enhancing quality learning through experiences of research-based learning: implications for academic development. *International Journal for Academic Development*, *17*(1), 47–58. https://doi.org/10.1080/1360144X.2011.586461

Carneiro, R., Lefrere, P., Steffens, K., & Underwood, J. (2011). Self-Regulated Learning in Technology Enhanced Learning Environments A European Perspective. In R. Carneiro, P. Lefrere, K. Steffens, & J. Underwood (Eds.), *Technology Enhanced Learning* (Volume 5). Sense Publishers. https://doi.org/10.1007/978-94-6091-654-0_1

Cassidy, S. (2011). Self-regulated learning in higher education : identifying key component processes. *Studies in Higher Education*, *36*(8), 989–1000.

Chabaya, O., Chiome, C., & Chabaya, R. (2009). Students' failure to submit research projects on time: a case study from Masvingo Regional Centre at Zimbabwe Open University. *Open Learning: The Journal of Open and Distance Learning*, *24*(3), 211–221. https://doi.org/10.1080/02680510903201615

Cheng, K. H., Liang, J. C., & Tsai, C. C. (2013). University students' online academic help seeking: The role of self-regulation and information commitments. *Internet and Higher Education*, *16*(1), 70–77. https://doi.org/10.1016/j.iheduc.2012.02.002

Christie, M., & Jurado, R. (2013). Using Communicative Action Theory to Analyse Relationships Between Supervisors and Phd Students in a Technical University in Sweden. *Högre Utbildning*, *3*(3), 187–197. http://pjos.org/ojs/index.php/hus/article/view/5650

Dabbagh, N., & Kitsantas, A. (2005). Using web-based pedagogical tools as scaffolds for self-regulated learning. In *Instructional Science* (Vol. 33, Issues 5–6, pp. 513–540). https://doi.org/10.1007/s11251-005-1278-3

Delen, E., & Liew, J. (2016). The Use of Interactive Environments to Promote Self-Regulation in Online Learning: A Literature Review. *European Journal of Contemporary Education*, *15*(1), 24–33. https://doi.org/10.13187/ejced.2016.15.24

Duick, D. S., & Baskin, S. H. J. (2012). *Design Science at the Intersection of Physical and Virtual Design*. springer. https://doi.org/10.1007/978-3-642-38827-9_40

Ge, X. (2013). Designing Learning Technologies to Support Self-Regulation During Ill-Structured Problem-Solving Processes. In R. Azevedo & V. Aleven (Eds.), *International Handbook of Metacognition and Learning Technologies* (pp. 213–228). Springer New York. https://doi.org/10.1007/978-1-4419-5546-3_15

Gibbons, P., & Hammond, J. (2005). Putting scaffolding to work: The contribution of scaffolding in articulating ESL education. *Prospect : An Australian Journal of TESOL*, *20*(1), 6–30.

Hansson, H., Collin, J., Larsson, K., & Wettergren, G. (2010). Sci-Pro improving universities core activity with ICT supporting the scientific thesis writing process. *Sixth EDEN Research Workshop - Budapest, 2010*. http://su.diva-portal.org/smash/record.jsf?pid=diva2:386466

Harrison, M. E., & Whalley, W. B. (2008). Undertaking a Dissertation from Start to Finish: The Process and Product. *Journal of Geography in Higher Education*, *32*(3), 401–418. https://doi.org/10.1080/03098260701731173

Jaldemark, J. (2012). Boundless Writing: Applying a Transactional Approach to Design of a Thesis Course in Higher Education. In A. Olofsson & J. O. Lindberg (Eds.), *Informed design of educational technologies in higher education : enhanced learning and teaching* (pp. 135–151). https://doi.org/10.4018/978-1-61350-080-4.ch008

Kardash, C. M. (2000). Evaluation of undergraduate research experience: Perceptions of undergraduate interns and their faculty mentors. *Journal of Educational Psychology*, *92*(1), 191–201. https://doi.org/10.1037//0022-0663.92.1.191

Kretchmar, J. (2013). Constructivism. *Research Starters: Education (Online Edition)*. https://ezp.sub.su.se/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=ers&AN=89164134&site=eds-live&scope=site

Lin, A. C. H., & Gregor, S. (2006). Designing websites for learning and enjoyment: A study of museum experiences. *International Review of Research in Open and Distance Learning*, *7*(3). https://doi.org/10.19173/irrodl.v7i3.364.

March, S. T., & Smith, G. F. (1995). Design and natural science research on information technology. *Decision Support Systems*, *15*(4), 251–266. https://doi.org/10.1016/0167-9236(94)00041-2

Ning, H. K., & Downing, K. (2010). The reciprocal relationship between motivation and self-regulation: A longitudinal study on academic performance. *Learning and Individual Differences*, *20*(6), 682–686. https://doi.org/10.1016/j.lindif.2010.09.010

Nozal, C. L., Pastor, J. F. D., Raedo, J. M., & Sanchez, R. M. (2013). An Innovative Moodle Final Project Management Module for Bachelor and Master's Studies. *IEEE Revista Iberoamericana de Tecnologias Del Aprendizaje*, *8*(3), 103–110. https://doi.org/10.1109/RITA.2013.2273109

Peffers, K., Tuunanen, T., Rothenberger, M. a., & Chatterjee, S. (2007). A Design Science Research Methodology for Information Systems Research. *Journal of Management Information Systems*, *24*(3), 45–77. https://doi.org/10.2753/MIS0742-1222240302

Peiris, C. R., Barbutiu, S. M., & Hansson, H. (2018). About the Challenges in Undergraduate Research Projects: An Explorative Case Study in a Sri Lankan National University. *International Journal of Learning, Teaching and Educational Research*, *17*(2), 25–44. https://doi.org/10.26803/ijlter.17.2.2

Peiris, C. R., & Hansson, H. (2017). ICT Support for The Thesis Process: A Case as a Literature Review. *Proceedings of the European Distance and E-Learning Network 2017 Annual Conference*, 113–122. https://doi.org/doi.org/10.38069/edenconf-2017-ac-0018

Peiris, C. R., Hewagamage, K., Hansson, H., & Wickramanayake, G. (2013). An Analysis of Existing Issues in Students' Research and Project Initiation Stage: Information and Communication Technology Perspective. *INTED2013 Proceedings*, 1760–1769.

Perera, M. A. N. R. (2014). Problems faced by undergraduates in the learning environment: some evidences from a Sri Lanka university. *Sri Lanka Journal of Advanced Social Studies*, *3*(1), 77–100. https://doi.org/10.4038/sljass.v3i1.7129

Pintrich, P. R. (1999). The role of motivation in promoting and sustaining self-regulated learning. *International Journal of Educational Research*, *31*(6), 459–470. https://doi.org/10.1016/S0883-0355(99)00015-4

Pintrich, P. R. (2003). A Motivational Science Perspective on the Role of Student Motivation in Learning and Teaching Contexts. *Journal of Educational Psychology*, *95*(4), 667–686. https://doi.org/10.1037/0022-0663.95.4.667

Saye, J. W., & Brush, T. (2002). Scaffolding critical reasoning about history and social issues in multimedia-supported learning environments. *Educational Technology Research and Development*, *50*(3), 77–96. https://doi.org/10.1007/BF02505026

Sulisworo, D., Agustin, S. P., & Sudarmiyati, E. (2016). Cooperative-blended learning using Moodle as an open source learning platform. *International Journal of Technology Enhanced Learning*, *8*(2), 187–198. https://doi.org/10.1504/IJTEL.2016.078089

Todd, M., Bannister, P., & Clegg, S. (2004). Independent inquiry and the undergraduate dissertation: perceptions and experiences of final- year social science students. *Assessment & Evaluation in Higher Education*, *29*(3), 335–355. https://doi.org/10.1080/0260293042000188285

Venable, J., Pries-Heje, J., & Baskerville, R. (2012). A Comprehensive Framework for Evaluation in Design Science Research. *Proceedings of the 7th International Conference on Design Science Research in Information Systems: Advances in Theory and Practice*, *32*(2), 423–438. https://doi.org/10.1007/978-3-642-29863-9_31

Vygotsky, L. S. (1980). *Mind in Society: The Development of Higher Psychological Processes* (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds.). Harvard University Press. https://doi.org/10.1007/978-3-540-92784-6

Walls, J. G., Widmeyer, G. R., & El Sawy, O. A. (1992). Building an Information System Design Theory for Vigilant EIS. *Information Systems Research*, *3*(1), 36–59.

Wenderholm, E. (2004). Challenges and the elements of success in undergraduate research. *9th Annual Conference on Innovation and Technology in Computer Science Education (ITiCSE)*, *Annual Joi*(4), 73–75. https://doi.org/10.1145/1041624.1041661

Wijesinghe, C., Hansson, H., & Peiris, C. R. (2018). University-Industry Collaboration for ICT Innovation in Sri Lanka. *Proceedings of E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2018*, 407–412. https://www.learntechlib.org/p/185008

Wilson, K., & Devereux, L. (2014). Scaffolding theory: High challenge, high support in Academic Language and Learning (ALL) contexts. *Journal of Academic Language & Learning*, *8*(3), 91–100.

Yi, M. Y., & Hwang, Y. (2003). Predicting the use of web-based information systems: Self-efficacy, enjoyment, learning goal orientation, and the technology acceptance model. *International Journal of Human Computer Studies*, *59*(4), 431–449. https://doi.org/10.1016/S1071-5819(03)00114-9

Zimmerman, B. J. (1989). A Social Cognitive View of Self-Regulated Academic Learning. *Journal of Educational Psychology*, *81*(3), 1–23.

Zimmerman, B. J. (2002). Becoming a Self-Regulated Learner: An Overview. *Theory Into Practice*, *41*(2), 64–70. https://doi.org/10.1207/s15430421tip4102_2

Zimmerman, B. J., & Campillo, M. (2003). Motivating Self-Regulated Problem Solvers. In J. E. Davidson & R. J. E. Sternberg (Eds.), *The Psychology of Problem Solving* (pp. 233–262). Cambridge University Press. https://doi.org/10.1017/CBO9780511615771.009

Zimmerman, B. J., & Cleary, T. J. (2009). Motives to self-regulate learning: A social cognitive account. In *Handbook of motivation at school.* (pp. 247–264). Routledge/Taylor & Francis Group.

Zimmerman, B. J., & Schunk, D. H. (Eds.). (2011). *Handbook of Self-Regulation of Learning and Performance*. Taylor & Francis.