Application of Gamification as a support for strategizing in Self-regulated Learning

von / presented by

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Aachen, 04.02.2020
Abstract

There are many ways in which a learner learns, self-regulated learning is foremost among them. As the name suggests, self-regulated learning is driven by the learner himself. Students approach learning activities with goals and self-efficacy for goal attainment. When they perceive satisfactory progress, students become more motivated while setbacks require them to understand what went wrong and take remedial steps. Since this type of learning is heavily dependent on learner’s own motivation and zeal to accomplish academic goals, researchers have used gamification frequently to support self-regulated learning. Gamification has proven to be effective to engage learners and enhance motivation towards their goal. However, on analysis of the various gamified elements, we observed that there is no single implementation that works to enhance goal setting, which is a crucial part of the self-regulated learning process. This thesis attempts to address this void with a tool that would support students to plan their studies. ‘Learning Strategizer’ is a Moodle based plugin developed to aid self-regulated learners to “strategize” their studies for better results in the latter phases of self-monitoring and self-reinforcement. The plugin suggests to learners, carefully tailored learning paths created by teachers alongside providing the opportunity to create paths of their own, based on educator specified guidelines. This plugin aims to instil a sense of control and authority among students as well as improve their self-awareness as a learner. In this thesis, we describe the process of developing the Learning Strategizer and discuss the results of its usability evaluation to eventually decide whether the tool has been successful in supporting learners in goal setting and planning their studies.
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**List of Abbreviations**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSS</td>
<td>Cascading Style Sheets</td>
</tr>
<tr>
<td>DB</td>
<td>Database</td>
</tr>
<tr>
<td>FSM</td>
<td>First Steps Module</td>
</tr>
<tr>
<td>GLEL</td>
<td>Gestalt's Law: Experience Law</td>
</tr>
<tr>
<td>GLPL</td>
<td>Gestalt’s Law: Proximity Law</td>
</tr>
<tr>
<td>GLSL</td>
<td>Gestalt’s Law: Similarity Law</td>
</tr>
<tr>
<td>GR</td>
<td>Golden Rule of interface design</td>
</tr>
<tr>
<td>GUI</td>
<td>Graphical User Interface</td>
</tr>
<tr>
<td>HTML</td>
<td>Hyper Text Markup Language</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communication Technology</td>
</tr>
<tr>
<td>LMS</td>
<td>Learning Management System</td>
</tr>
<tr>
<td>MOOC</td>
<td>Massive Open Online Courses</td>
</tr>
<tr>
<td>PHP</td>
<td>PHP: Hypertext Preprocessor</td>
</tr>
<tr>
<td>RWTH</td>
<td>Rheinisch Westfälische Technische Universität</td>
</tr>
<tr>
<td>SP</td>
<td>Stimulated Planning</td>
</tr>
<tr>
<td>SRL</td>
<td>Self-Regulated Learning</td>
</tr>
<tr>
<td>ST</td>
<td>Student Task</td>
</tr>
<tr>
<td>SURE+E</td>
<td>Study, Use, Review, Enjoy and Evaluate</td>
</tr>
<tr>
<td>TT</td>
<td>Teacher Task</td>
</tr>
<tr>
<td>UI</td>
<td>User Interface</td>
</tr>
<tr>
<td>URL</td>
<td>Uniform Resource Locator</td>
</tr>
<tr>
<td>WIN</td>
<td>Want Interests Need</td>
</tr>
<tr>
<td>XML</td>
<td>Extensible Markup Language</td>
</tr>
</tbody>
</table>
Chapter 1 Introduction

This chapter informs about the overall motivation and objective of the thesis. It states the research question and describes the proposed technical solution. Finally, this chapter concludes with a brief overview of the remaining thesis structure.

1.1 Motivation

Self-regulated learning (SRL) is the application of self-regulation—the ability to concentrate, getting involved in group activities, restrain disruptive and impulsive behavior and work autonomously—in the domain of learning attainment. A self-regulated learner needs to [1] [2]

- set realizable learning goals
- focus on instruction
- implement effective strategies to organize their learning
- use available resources efficiently
- monitor performance
- manage time effectively
- have confidence in their own capabilities.
- stay determined to achieve their goals

Research on self-regulated learning has indicated motivation to be an important domain that learners try to self-regulate. This involves implementing various ways to boost their self-efficacy and strategies to control their interests [3]. A way used by researchers to enhance learner’s determination in self-regulated learning is gamification.

When players play games—especially video games—they show intense motivational and emotional involvement. The idea of gamification is to improve user engagement through this motivational power of games in non-entertaining domains by incorporating gamified elements, principles or mechanics [4]. The common gamified elements help learners in two ways. Firstly, gamified elements help to enhance their performance in a learning activity. Challenges and Time Track are a good example of this. Learners can test their understanding through challenges and track their time to assess if they are able to meet their desired proficiency level. The second way gamification assist learners is to self-reflect and understand where they stand in comparison to their peers. Leaderboards, experience points, badges, rewards are examples of such utility [5].

Barry J. Zimmerman presented a model that divides self-regulated learning in three phases-Forethought Phase, Performance Phase and Self-reflection. The forethought phase deals with learners assessing their academic situation and choosing strategies to overcome a specific learning goal. During the performance phase, learners implement their chosen strategies and monitor their progress. Lastly in the self-reflection phase, learners evaluate the effectiveness of their strategies in terms of goal attainment [6] [7]. Mapping of prevalent gamified elements to Zimmerman’s model shows that they support either the performance or the self-reflection phases. However, there is no single gamified element to support the forethought phase [5]. The forethought phase acts as a safeguard against disorganization and procrastination [8], hence it is necessary to build a tool that aids learners during this phase alongside maintaining motivation and engagement.
1.2 Objective

When prevalent gamified elements were analyzed, it was found that there was no single gamified element that fully supported the forethought phase. Thus, the focus shifted to studying gamification in detail and choose design principles, mechanics or elements that can be utilized to realize a forethought phase aiding tool. This bring us to our research question:

“How can we apply gamification as a support for strategizing Self-Regulated Learning?”

In this thesis, various gamification design principles, mechanics and elements are studied and an attempt has been made to provide a solution in the form of a Moodle plugin ‘Learning Strategizer’ that aids learners to ‘strategize’ their learning during the forethought phase of self-regulated learning.

Procrastination and disorganization are proven to be two distinct yet intercorrelated processes leading to SRL failure. Low quality forethought processes, such as inadequate goal-orientation, insufficient self-efficacy, eventually results in learners not achieving their goals and/or desired level of achievement. Hence proper planning, setting realistic goals during forethought phase is crucial to develop a positive mindset and maintain required levels of motivation [8].

The ‘Learning Strategizer’ is a Moodle block plugin centered around learning paths. Learning path is a selection of courses tied together for learners to progress through, mastering a particular subject or program [9]. Since the basic structure of the open source learning platform, Moodle, is developed around courses [10]; learning paths here refers to a sequence of course materials (lecture files, quizzes, workshops, assignments) that the learners have to progress through in order to achieve their desired qualification in the course. ‘Learning Strategizer’ helps learners plan their study by

- Either choosing a learning path from a collection of paths carefully tailored by teachers
- Or creating their own learning path abiding by rules specified by teachers.

The plugin offers additional features such as a milestone view of learner’s progress through various sections of the course and visual analytics providing information like which learning path is chosen by most, which resources are completed by most etc. This plugin establishes a collaboration between teachers and learner’s maintaining the latter’s autonomy. The plugin invites teachers to define learning paths that learners can choose from and specify rules for learners who wish to create their own learning path. Teachers are also responsible for assessing the appropriateness of learning paths created by learners.

<table>
<thead>
<tr>
<th>FORETHOUGHT PHASE</th>
<th>PERFORMANCE PHASE</th>
<th>SELF-REFLECTION PHASE</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Gamified Elements" /></td>
<td><img src="image" alt="Gamified Elements" /></td>
<td><img src="image" alt="Gamified Elements" /></td>
</tr>
</tbody>
</table>

Figure 1 No gamified element available for forethought phase
This tool hopes to serve as an efficient tool with which students can prepare their learning path to achieve their desired academic proficiency.

1.3 Structure of the Thesis
The remainder of the thesis is structured as follows. Chapter 2 discusses, in details, the two main concepts of this thesis—gamification and self-regulated learning (SRL)—and explores the correlation between them. This eventually leads to the identification of the missing link between them and describes the inception of Learning Strategizer plugin. It, thereafter, offers a brief overview of Moodle and discusses the reason for choosing it as the implementation platform.

Chapter 3 reviews the current state of the art in terms of supporting forethought phase of SRL including, but not restricted to, gamification. The chapter concludes with a research on current Moodle plugins that were analyzed to develop the Learning Strategizer. Chapter 4 analyzes and discusses the user classes, environment, functional and non-functional requirements for the Moodle plugin. Chapter 5 explains the various use cases of the plugin, the principles followed for designing the user interface and eventually the entire software architecture. Chapter 6 describes the implementation of the Learning Strategizer by elaborating on the different views of the plugin and its associated functionalities. Chapter 7 discusses the usability study conducted to evaluate the plugin. It explains the test environment, the evaluation techniques used and the results of the study. Finally, Chapter 8 concludes this thesis by answering whether the Learning Strategizer plugin accomplished the objectives it set out with and presents possible future work.
Chapter 2 Fundamentals

This chapter elaborates on the key topics of the thesis—self-regulated learning (SRL) and gamification. The topics are formally defined, and their origin and impact are discussed. The interrelation between the two concepts is discussed leading to the discovery of missing link between them. The latter part of the chapter is dedicated to online learning with special focus on the chosen learning platform—Moodle. The chapter concludes with description of the solution to address the void between gamification and SRL i.e. Learning Strategizer.

2.1 Self-regulated Learning: Origins, Definition and Zimmerman’s cyclical model

2.1.1 Origin of SRL

The origin of self-regulated learning lies in the learning theory of cognitivism. Cognitivism focuses on what happens in the mind such as thinking and problem-solving. The learning theory equates learning with discrete changes between states of knowledge. New knowledge is built upon prior knowledge and learners need to be active participants, willing to learn. Changes in behavior are observed, as an indication of what is happening inside the learner’s mind. Cognitivism uses the metaphor of the mind as a computer: information comes in, gets processed, and learning takes place. Cognitive theories focus on the conceptualization of learners’ learning processes and address the issues of how information is received, organized, stored, and retrieved by the mind. Learning is concerned not with what learners do but more with what they know and how they come to acquire it [11]. Metacognition is a subdivision of cognitivism since it deals with the scientific study of an individual’s cognitions about his or her own cognitions. It is defined in simplest terms as “thinking about your own thinking.” It is instrumental for learning because it influences acquisition, comprehension, retention and application of what is learned. It also impacts learning efficiency, critical thinking and problem solving. An example illustrating the correlation between cognitivism and metacognition can be as follows:

<table>
<thead>
<tr>
<th>Cognitive Task/Strategy Example</th>
<th>Metacognitive Task /Strategy Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of finding the sum of a set of numbers</td>
<td>Add the numbers up again</td>
</tr>
<tr>
<td>Remembering things learned earlier that might help with current task or problem</td>
<td>Monitoring and directing the processes of problem solving</td>
</tr>
</tbody>
</table>

Table 1 Correlation between cognitivism and metacognition adapted from [12]

Cognitive strategies are basically knowing how to reach a goal while metacognitive strategies make sure that the goal was reached successfully, such as double or triple checking the correct answer.

A new perspective on students’ individual differences began to emerge from research on metacognition. The research focused on how students could self-regulate themselves to improve their learning, how they can overcome their individual limitations to understand their suitable learning style, develop strategies, evaluate and/or modify them to achieve their academic goals. This process of taking control of and evaluating one’s own learning and behavior was referred to as self-regulated learning [13] [14].
2.1.2 What is SRL?

Self-regulated learning (SRL) implies that learners have the ability to monitor and control their own learning process [15]. It involves use of various cognitive and metacognitive strategies to control, monitor and regulate their cognition, behavior and motivation during a learning activity [13]. Students practicing such self-regulation have shown to be proactive in their efforts to learn since they know what they can and cannot do. While others rely on the pedagogical ways, which might not prove effective in all cases, these students practice effective strategies and approaches to overcome their limitations. They are very aware of their abilities and how they compare to others. Thus, these learners understand that not everyone can achieve the same aim in the same hours or by implementing the same training method. Therefore, they develop their own personalized goals based on their potential and monitor themselves in correspondence to them. Self-regulated learners might lag initially but their superior motivation, self-awareness and adaptive learning methods make them more likely to not only succeed academically but also to view their future optimistically. Self-regulated learners select personally adapted processes according to the academic goal they wish to achieve. In an SRL environment, learners can be more active and efficient to improve their final learning outcomes. Self-regulated learners have abilities to change and develop their own learning strategies based on self-understanding and examine their learning through constructive activities, collaborative work, and free exploration. SRL is a cognitively and motivationally active approach to student-centered learning [16].

2.1.3 Zimmerman’s cyclical SRL Model

There are different theories that explain how self-regulated learning works [17] and many researchers have presented their own models illustrating the process of SRL [18]. Barry J. Zimmer stipulated that to engage in SRL, a learner needs to

- monitor how learning is carried out
- judge the quality of engagement and the results it produces
- react to this judgement when there are differences between desired standard and results [19]

Based on his research, Zimmerman developed a cyclical SRL model which is one of the most comprehensive models in the domain and presents specific information how the different process in SRL work. Before going to the details of this model, it is required to mention that Zimmerman had two other SRL models:

1. **Triadic model of SRL** depicting interactions of three forms of SRL from social cognitive perspective: environment, behavior and person [20]
2. **Multi-level model of SRL** explaining the instruction and acquisition of self-regulatory processes [21]

Nevertheless, most studies refer to the cyclical phase model as the main model from Zimmerman, hence in this thesis we will restrict ourselves to this model only and refer to the cyclical model as Zimmerman’s model.

*Evolution of the model:* The cyclical phase model was first presented in 2000 alongside a separate table where the processes were categorized into each of the three phases [21]. In 2003, the model was reformed to include the processes within the figure itself [22]. Finally, in 2009, the model was modified including more processes in the performance phase and defining the processes in more detail and describing how they interact.
**Cyclical Model Description:** Barry J. Zimmerman’s cyclical SRL phases model (Figure 2) is organized into mainly three phases [23]:

1) Forethought (also known as Preparatory)
2) Performance
3) Self-Reflection (also known as Appraisal)

![Figure 2 Zimmerman's cyclical SRL model adapted from [23]](image)

In the initial forethought phase, students approach the tasks, analyze them, assess their capacity to perform them, establish goals and plan regarding how to accomplish them [24]. The Forethought Phase is divided into two sections: Task Analysis and Self-Motivation Beliefs. Task Analysis deals with learners breaking their ultimate academic goals into smaller goals and strategizing how to accomplish them. The second section dealing with self-motivation focuses on self-efficacy which is an individual’s beliefs in their own abilities to achieve the academic outcome they expected to fulfill. Task interest and goal orientation deals with evaluating the merit of the task skill and subject matter with respect to the learner’s goals. As the learners start to understand and acknowledge the value of the subject matter, they become more motivated to enhance their mastery over it. In the performance phase, individuals employ the strategies agreed upon in the forethought phase and deploy them in practice. The self-reflection phase comprises of self-judgment and self-reaction. In self-judgment, the learners evaluate their methods compared to their own in a different setting or to another person’s performance. Self-reaction can be viewed in three ways: positive, defensive and adaptive. The positive
view is when the application of the chosen strategies has yielded satisfactory results. Self-satisfaction is a major influencing factor in self-regulated learning. When positive, it can enhance motivation among students but on the other hand decrease in self-satisfaction can undermine further efforts to learn. Adaptive view of self-reaction is when learners modify their learning plan to get better results. On the contrary, defensive reactions induced in students accounts for when they choose to avoid opportunities to learn e.g. dropping a course. Learners primarily do this to avoid inconsistencies in their performance graphs. As understandable from Zimmerman’s model, the SRL framework is cyclical where the self-reflection of previous efforts serves as guides in the subsequent forethought processes. [6]

Significance of the model: Zimmerman’s model contributed immensely in the domain of SRL since it encompasses cognitive, behavioral and motivational aspects as well as explaining, in great detail, the relationship between motivation and self-regulation. The model is comprehensive since it covers, in great detail, majority of the key processes involved in a self-regulated learner’s learning activity and also offers a theoretical framework to determine relevant aspects in case of improvement.

Due to these reasons, Zimmerman’s cyclical phase SRL model was chosen for this thesis

2.2 Gamification

2.2.1 What is gamification?

According to Kapp, gamification is “using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems” [25]. There are various overlapping definitions, but they can be summarized as follows: Gamification is the application of game-design elements and game principles in non-game contexts. The concept has been inspired by how gamers invest countless hours voluntarily in developing their problem-solving skills within the context of a game. Through extended gameplay, they realize the implications of repeated practice, value of persistence, implementation of creativity and resilience. Gamification intends to harness this perseverance and motivation of gamers onto real-world contexts [26]. Before proceeding further on the topic of gamification, it is necessary to define the following terms and concepts related to gamification—game mechanics, game elements, game dynamics (also known as gameplay) and gamification design principles. These terms have similarities among themselves, but their differences need to be clarified (Table 2).

<table>
<thead>
<tr>
<th>Game Mechanics</th>
<th>Game Elements</th>
<th>Game Dynamics (also known as Gameplay)</th>
<th>Gamification Design Principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>The rules and procedures that guide the player and the game response to the player’s moves or actions [27]</td>
<td>Features in a game that keep people or players engaged [28]</td>
<td>The patterns of how both the game and the players will evolve over time and that will make the gamified activity enjoyable and keep the user engaged for as long as possible.</td>
<td>Evaluative guidelines to approach a design problem or analyze a given design solution [29]</td>
</tr>
</tbody>
</table>

Table 2 Game Mechanics vs Game Elements vs Gamification Design Principles adapted from [27] [28] [29]
2.2.2 Why Gamification?

In the field of education, gamification has garnered attention in recent years as an effective mean to engage students and increase their performance. Gamification in education is the use of game mechanics and elements in the academic setting; implementation of which has improved in e-learning platforms based on modern ICT that processes student data, track their progress and create reports that assist both students and teachers [30]. Both in a classroom setting and self-regulated learning environment, the lack of motivation and engagement among students is a problem.Gamification addresses this issue by providing the component of fun that helps in transforming student’s attitudes towards learning. The role of fun in a learning process is to create relaxation and motivation. Relaxation makes learners take things in more easily whereas motivation enables them to put forward effort without resentment [31]. Video games for many of its’ players, induce a feeling of fun through the feeling of achievement, sense of exploration, reward of finishing a level or simply winning the game. This element of play when incorporated into learning experience can bring about intrinsic interest in learning. For many learners, the fun part in a gamified learning setting is the outcome of solving problems and overcoming challenges deploying critical engaging thinking skills. Gamification involves learners to exert their best effort and become mindful; which, in turn, lead to deeper understanding and learning [32][33]. Furthermore, application of gamification has been proven to improve the ability to learn new skills by 40% [34]. Gamification is not directly connected to knowledge and skills rather it effects a learner’s behavior, motivation and engagement which, in consequence, enhances their knowledge and skill levels [26]. Due to its’ positive effects on learner motivation, gamification is the choice of technique for supporting SRL in this thesis.

2.3 SRL and Gamification

![Figure 3 Task mapping to SRL model phases in gamified e-learning](image-url)
Applying Zimmerman’s SRL model to gamified e-learning platforms (Figure 3), the forethought phase will consist of students reviewing the course materials, setting goals and selecting their preferred learning methods. In the performance phase they will work towards their academic goals implementing their preferred learning method, collaborate with fellow learners and monitor their progress. In the final self-reflection stage the students will evaluate their understanding and decide to change or continue their learning method based on grades or forum discussions [35].

2.3.1 Missing Link Identification

The study of prevalent gamified elements in eLearning revealed that majority of them support either performance or self-reflection phases of Zimmerman’s model since they help students to either implement/test what they learnt (challenges, quizzes, etc.) or assess themselves based on performance (rewards, badges, leaderboards). There was no single game element that aided the forethought phase by helping students review the materials and offer or assist in choosing a suitable learning method.

2.3.2 Inspiration

**Strategy Game Element:**
Studying general gamification mechanics and elements, strategy was a concept that aligned closely to the aim of the forethought phase. It has been classified as a combination of game element, mechanic and dynamic. The general idea of the strategy is to lead its user to think about what they are doing, why they are doing it and how they would do it to achieve the desired outcome [5] [36]. This is very similar to metacognition theories where lies the origin of SRL. Implementation of the strategy gamification element within a learning environment required [37]:

- Inclusion of tradeoffs that influence learner’s choices
- Provide information to influence and shape learner’s choices
- Positive reinforcements on developing an effective solution

**Branching Choices and Freedom of Choice:** Strategy required the learners to make choices best suited to them. This brought us to another game element— ‘Branching Choices’. The idea of branching choices is to let the user choose their own path and destiny. Research on gamification design principles revealed a similar design principle, ‘Freedom of Choice’ which is conceptualized as multiple routes to success, allowing students to choose their own sub-goals within the larger task. One of the dominant game features that keep gamers engaged is active experimentation. There is not a single route for success in the game which invokes gamers to try different techniques and detours to achieve their goal. When we look at the typical classroom learning environment this was a feature that was not prevalent. A student taught in class by the teacher, was expected to prove his understanding through one final exam at the end of the term. If we propose more than one way for students to prove their competence, it can transform a learner’s perspective on learning, especially self-regulated learners who are always testing to find the most suitable method to be more motivated. This concept of choosing among different methods of goal achievement is the ‘Freedom of Choice’ principle. Freedom of Choice lets the learners explore different learning paths and achieve their academic goals following the one that suits them. This can be implemented by giving students other ways to succeed like contributing to open-ended group or individual projects; writing academic papers, creating an instructional YouTube video etc. [38].

**Freedom to Fail:** An effective Freedom of Choice implementation requires the learners to test the various course of actions to find what works for them [39]. Learners can truly explore when they know that there is no negative
consequences. This brings us to another gamification design principle—Freedom to Fail. The importance of failures in achieving success has been preached by philosophers since centuries. Despite that, failure is not a very celebrated topic in education and is associated with negative emotions. Since games involve active experimentation it evokes the correct response to failures. In fact, in most games the players must fail repeatedly in order to achieve success. The reason this positive perspective about failure has managed to form in games is because gamers have very little to lose and are immediately informed about what they did wrong. In the learning scenario, things are quite opposite. Students have very few attempts with long feedback cycles and the stakes get higher with each try leading to anxiety, frustration among students [40]. The gamification design principle ‘Freedom to Fail’ aims to rectify this through low risk from submissions and allowing multiple attempts. Through low stake quizzes or mock exams, gamification can help students understand the effectiveness of the method or learning path they have undertaken. In this way students can stop viewing failure as a dead-end but a window to learn from their mistake and better themselves [38].

2.3.3 The Idea

A good support tool for the Forethought phase should be a culmination of these element, mechanic, dynamic and design principles. The idea is to create a strategic gamification element that would allow learners to plan their learning paths, choose components to build or extend their learning paths based on given information and prior knowledge or experience and in case a component doesn’t suit them, they can discard and try others until they find the correct one.

The remaining task was to find a suitable platform that

- supports gamification and SRL
- requires minimum effort of integration and
- reaches a significant set of learners

2.4 Moodle as a gamified LMS

Educational institutes use Learning Management Systems (LMS) to manage learning process and offer a variety of online courses with corresponding resources and activities. LMS are suitable environment for gamification because they are equipped with automatic tracking of student’s results and progress. Moodle (acronym for modular object-oriented dynamic learning environment) is one of the most popular learning platforms that allow teachers to manage online learning. It is also among those LMS that facilitate the gamification of the learning process.

Some of the Moodle gamification capabilities are:

- Learner’s picture/avatar giving them a gamified identity
- Visibility of learner’s progress through progress bars and tracking it in terms of ultimate course goals
- Display of quiz results giving a visualization of a learner’s acquired knowledge and skill level
- Levelling up based on improvement and progress of a learner
- Timely feedback letting the learners know where they went wrong in assignments, quizzes etc.
- Badges as a reward to recognize learner’s efforts
- Leaderboard displaying how learners compare to their peers [26]

Moodle is centered around courses which are places or areas within it where teachers can place their learning resources and activities for students. A course can have different layouts but it mostly includes a number of central sections where materials are displayed and side blocks offering extra features or information [41] [10]. The extra features or information are provided through plugins. Moodle plugins enable to customize
Moodle LMS as per learning and development needs [42]. Since Moodle 1.0 was released, more than 1,500 open-source plugins have been developed and added to the Plugin directory to make them available for every Moodle site [43]. Moodle is open source with sufficient resources relating to development and an active community to support and share ideas and development [44]. At RWTH Aachen University, the learning platform was officially transferred from L2P to the Moodle-based system RWTHMoodle in March, 2019.

Development of Moodle plugins is facilitated by the open documentation repository and active forum. Due to the extensive modularity of Moodle, the plugin installation process requires developers to simply place the developed plugin folder in the appropriate plugin type directory. Due to these beneficial factors, it was decided that the forethought phase support tool will be a Moodle plugin named ‘Learning Strategizer’ since it helped learners to ‘strategize’ their learning.

![Figure 4 Diagram depicting the inception of 'Learning Strategizer'](image-url)
Chapter 3  State of The Art

The first step to progress in the thesis, after familiarizing oneself with the fundamentals concepts of SRL and gamification, was research. In this chapter, related work in the field of SRL and gamification are discussed with special emphasis on gamified and non-gamified tools developed to support goal setting and planning in learning. The chapter concludes with discussion over the various Moodle plugins that were researched and contributed to the development of the Learning Strategizer.

3.1  SRL

There has been research on various study planning techniques supporting SRL in education both online and offline.

Software for Target-Oriented Personal Syllabus (STOPs) is a tool developed during a study focusing on curriculum modelling based on student’s academic goals. STOPs specify how the topics covered in each course are connected to other courses and the degree-level goals [45]. The Learning Strategizer plugin is developed to accomplish this but on a lower, course-specific level.

Open Universiteit’s Trusted Learning Analytics course introduces a method through which enrolled students can choose a learning path of their choice and undertake the course following the pattern of the path chosen. However, it doesn’t offer any opportunity to change the learning plan once students have selected one. This is a bottleneck of the method since not all students correctly understand what type of learning suits them [46]. Learning Strategizer overcomes this shortcoming by allowing students to change their learning path if they feel it is not working for them (Freedom of Choice and Freedom to Fail).

Creative tools promoting goal setting and self-reflective process in language learning advisory

A study discussed a number of cognitive tools to stimulate dialogue about goal setting and reflective processes among students at various stages of the language learning process. The chronological use of these tools aims to transform students into efficient self-regulated learners capable of planning their learning. Some of these tools are described below.

<table>
<thead>
<tr>
<th>NAME</th>
<th>TOOL DESCRIPTION</th>
<th>PROCESS &amp; EFFECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. First Steps Module (FSM)</td>
<td>Eight-week self-directed learning modules during which learning advisors interact with learners. Each module consisting of (1) Need Analysis, (2) Time Management, (3) Learning Styles, (4) Resources, (5) Affective Strategies (6) Learning Strategies (7) Balancing Your Learning and (8) Reflections, Each unit has many activities that learners can try.</td>
<td>Learners are made to write weekly reflective journals which combined with advisor’s comments on their attempted activity from the unit facilitates development of learner’s awareness of themselves as a learner and their internal dialogue. Advisors also choose and publish student reflections deemed insightful to inspire learner from their peer’s ideas</td>
</tr>
<tr>
<td>2. Learning Plans</td>
<td>A personalized eight week plan consisting of learner’s goals, learning styles, interests and selection of learning resources to achieve their goals</td>
<td></td>
</tr>
</tbody>
</table>
3. **SURE+E planning**

An activity model aimed to achieve a good balance of studying, understanding, enjoying and reviewing what they study among learners

Learners study, use and review learning materials they have chosen, state what they do to ‘enjoy’ their learning and finally ‘evaluation’ where the students describe how they check if they are making progress.

4. **WIN Analysis**

Advisors guide learners to consider all three areas of Want, Interest and Need for a greater understanding of learning aims and can ask them to prioritize

Method helps students to select self-directed objectives and prioritize in an informed way.

5. **Flower Tool**

A visual floral representation showing how interlinking components of self-directed learning fit together as a whole, each individual component being able to stand alone but also connected to and influencing other components through its core—the learner’s goal

Benefitted students who found it difficult to communicate their ideas verbally.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>SURE+E planning</td>
<td>An activity model aimed to achieve a good balance of studying, understanding, enjoying and reviewing what they study among learners. Learners study, use and review learning materials they have chosen, state what they do to ‘enjoy’ their learning and finally ‘evaluation’ where the students describe how they check if they are making progress.</td>
</tr>
<tr>
<td>4.</td>
<td>WIN Analysis</td>
<td>Advisors guide learners to consider all three areas of Want, Interest and Need for a greater understanding of learning aims and can ask them to prioritize. Method helps students to select self-directed objectives and prioritize in an informed way.</td>
</tr>
<tr>
<td>5.</td>
<td>Flower Tool</td>
<td>A visual floral representation showing how interlinking components of self-directed learning fit together as a whole, each individual component being able to stand alone but also connected to and influencing other components through its core—the learner’s goal. Benefitted students who found it difficult to communicate their ideas verbally.</td>
</tr>
</tbody>
</table>

**Table 3** List of creative tools used to promote goal-setting and self-reflective process in language learning advisory.

The tools discussed in this paper present some interesting methodologies that help students to self-regulate but the connecting element of extensive regular communication between learning advisors and learners is not practised at most higher education institutes. Learning Strategizer attempts to incorporate the essence of these methodologies so that the students can self-regulate in spite of lesser educator presence [47].

**EDUCAUSE’s personal learning service or support hub** housed at Open College at Purdue University encourages learners to assess themselves based on their career aspirations and current knowledge, define their upcoming learning goals with respect to academic or career terms, identify the gap between their current knowledge and ultimate goal and find open education resources that would help them to bridge this gap. This is established through several tools such as:

- **Learning Recognition Course** is a free course that builds a prior learning portfolio for the learner including requests for credit based on prior experiential learning.
- **Career Journey** is another free course that inspires and guides people in their career journey. It provides a personalized experience that integrates data based on the individual’s LinkedIn profile.
- **Learning Advisor** is a hub that includes free and paid courses, certificates, degree programs, insights and inspiration to help adult learners explore their learning possibilities [48].

These tools offer assistance to learners when they have come out of educational institutions. Learning Strategizer aims to provide similar services but to learners within an educational curriculum.

### 3.2 Gamification

All students have the ability to become ‘smart learners’ if they learn to use self-regulation techniques along with gamification activities in perfect harmony and organisation. An exact combination of self-regulation techniques can actively grasp the engagement of students in the learning process as well as promote the traditional teaching-learning activities to a new dimension resulting from new experience and habits [49]. A study to investigate perceived importance of gamification, social networking and quantified-self feature in goal setting reveals that being outcome-
focused is associated with positive evaluations of gamification. Goal setting facilitates self-regulation. Positive perception of gamification that leads to its adoption, mostly depends on user’s relationship with goals. Gamification is perceived positively by users whose goals are easy, outcome-focused and who are more driven to prove themselves to others [50].

Stimulated Planning
A prominent problem in online education, especially in Massively Open Online Courses (MOOCs), is the great difference between registered users and the number of users actually finishing the course. A possible reason can be that not all users entering a MOOC have the same goal. A study presented a tool called ‘Stimulated Planning’ (SP) that enabled learners to plan their intention within a MOOC, therefore assisting them to achieve their personal goals and eventually hiking the completion rate in the MOOC. The study suggested that redesigning MOOC in a way to foster user’s freedom of choice, planning as well as declaration of goals will benefit to enhance completion rate. The SP game element was implemented with reference to 3-step plan to (1) identify goal (2) specify if-then plan and (3) specify coping plan. It is derived from strategy games whereby giving users the chance to plan strategies; they feel empowered. Evaluation of the game element found that learners using the planning and coping functionalities performed better than learners working without a plan. The findings from the evaluation study can be interpreted in different ways. It can mean that the SP positively affected a learner’s goal achievement, but it can also imply that the tool appeals to goal driven users who are more focused to achieve their objectives. Therefore, although the study recognises the importance of goal setting and devised a tool for it, it fails to conclusively prove whether the tool truly helps learners to set and achieve their goals. This thesis draws inspiration from this study and attempts, with Learning Strategizer, to present a tool that will fully realise the effect of goal setting and attainment [51].

3.3 Moodle Plugin Research
Moodle states, “If you need a specific function for your site, it is probable that someone has needed it before and that a member of the Moodle development community, a Moodle Premium Integrator, a Moodle Partner or Moodle HQ have already developed a plugin for it. Search the Moodle Plugins directory by purpose or by type and find the plugin that can extend your learning platform the way that you want it” [43]. Therefore reviewing the existing Moodle Plugin Directory was the first step to develop the plugin.

Learning Plan plugin from 3i Logic LMS proved useful to base the foundation structure of the plugin since the process flow and objective were similar. The Learning Plan plugin allowed teachers or course managers to add ‘Learning Plans’ for a course and assign them to learners [52]. The Learning Plan, however, did not autogenerate course contents and it was fully dependent on teacher/course manager’s manual input. This could cause discrepancy and confusion; hence it was required that ‘Learning Strategizer’ generated the course contents dynamically. Thus, we searched next for plugins which detected and displayed course contents.

Course Contents is a block plugin that showed all course sections and provided link to navigate to the chosen section (or topic) of the course. The plugin was tested and although it could dynamically detect course sections, it did nothing to fetch the contents of the section. Hence, this plugin had to be discarded and the search was modified to look for a plugin that autodetected and displayed course section along with each of its’ contents [53].

Course Module Navigation block plugin, on first installation, behaved exactly like ‘Course content’, displaying only section with links to go to that section. However, on configuring the plugin settings from Site Administration to disable the ‘Show only titles’ option, the plugin could display the contents of each section/topic of the course as well [54].
Analytics graphs block plugin generates graphs intended to facilitate pedagogical decisions. The graphs have zoom capabilities and allows fast communication with students through email. It provided graphs and charts for visualizing grades, course modules access, number of active students, assignment submissions, quiz submissions and hits distribution. Although the plugin seemed very useful there were two distinct problems. Links to the graphs, from the main view of the plugin, redirected users to totally different pages where the graph was displayed. These pages had no links back to the course except for the default browser back button. The second problem with the plugin was that the code was very unclear hence integration was difficult [55]. Despite the drawbacks, the hovering and zooming capabilities of the plugin’s charts was an interesting feature, which was eventually utilized in Learning Strategizer’s visual statistics module.

Monitoring of learning plans is a report plugin that facilitates work of learning plan managers. It provides an overview of user learning plan, without leaving the page to get information related to the learning plan (such as rating in courses, user evidence, etc.). It also offers statistics on learning plans and competencies [56]. Although this plugin provided useful functionalities, it depended on Moodle’s built-in learning plans plugin. Hence this plugin was discarded from analysis.

Learning Outcome Generator is a block plugin generating sequences in form a flowchart that help lecturers to navigate to their required activity. The generator is used to create learning outcome sequences. It presents a GUI to the user that allows the visual creation of sequences [57]. This plugin’s idea was utilized to develop the student’s progress milestone chart in Learning Strategizer.
Chapter 4  System Requirements

This chapter introduces the distinct user classes of the plugin and the development environment of the plugin. The latter part of the chapter lists functional and non-functional plugin requirements.

4.1 User Classes

Conceptually, the plugin distinguishes between two different classes of users—learners and teachers. Learners are users who are enrolled in a course with ‘Student’ role in Moodle. With reference to the plugin, the learner’s main function is to plan their progress through each section of the course by following a learning path. This learning path can either be chosen from a set of teacher-defined learning paths or made by themselves following guidelines specified by teachers. In addition, learners can track their progress through the course and view statistics regarding resources and learning paths that assist them to choose paths.

Teachers are users enrolled in a course with the special ‘Teacher’ role in Moodle. They represent the instructors for a course. The main functions of teachers are to publish learning paths that the learners can choose from and to approve or reject learning paths requested by learners. Like learners, teachers can also view statistics regarding resources and learning paths.

4.2 Environment

The plugin is designed for the LMS Moodle and therefore the operating environment is a Moodle installation, hosted on a PHP-capable web server. Moodle is written in PHP, generating static HTML pages that make use of both CSS and JavaScript. The operating system used during entire development this thesis is Windows 10 but, as per Moodle, Unix or Linux and Mac works as well [58].

4.3 Functional Requirements

Before starting the implementation, it was needed to establish the basic objectives and functions that the plugin needed to offer. The plugin needs to be

- Standalone
- Have no restrictions on the course content and should only act as a guide
- Should have a distinct student and teacher module
- Teachers should be able to build learning paths with the tool which will become the pre-defined learning paths, the students can choose from
- Students should be able to choose learning paths from the pre-defined ones the teachers made. (Freedom of Choice)
- Students can also create their own learning path
- In case the students make their own learning path, the teacher should be able to approve or reject their plan.

These were the initial objectives listed out in the proposal of the thesis. After consultation with fellow tutors and teachers, a few observations were made.
• Learning Path created shouldn’t be immediately available to students since the teacher might make mistakes while creation

• Some way of seeing what Learning Paths are popular among students, which material is tough for students etc. maybe through some visual insightful analytics

• Students should be able to view their progress

• If a Learning Path is not working for students midway in the course, he/she can try and switch to other plans (Freedom to Fail)

Keeping the observations from teachers and tutors in mind, the initial objective list was revised to form the final functional requirements of the plugin. These requirements can be categorized into four parts—plugin specific, teacher specific, learner specific and common to both sets of users. The functional requirements are as below:

**Plugin Specific**

FR1.1. Standalone

FR1.2. Have no restrictions on the course content and should only act as a guide

FR1.3. Should have a distinct student and teacher module

**Teacher Specific**

FR2.1. Teachers should be able to build learning paths which will become the pre-defined learning paths, the learners can choose from.

FR2.2. Learning Path created by teachers will not be available immediately to learners but will be available when teachers choose to ‘publish’ them.

FR2.3. After creating a Learning Path, teachers can modify the paths or delete the path as a whole.

FR2.4. Once a path is published it cannot be deleted or modified by the teacher.

FR2.5. When teachers create a learning path in the course, they must do so for the whole course i.e. it should have requirements from all sections of the course.

FR2.6. The resources that teachers mark as ‘Required’ become mandatory for students who make their own learning path.

FR2.7. Teachers should mark the same resources as ‘Required’ in all learning paths they create.

FR2.8. In addition to completion of course modules, teachers can set additional rules that learners who make their own learning paths need to abide by.

FR2.9. Teachers should be able to approve or reject learning paths created by learners. In the case of rejection, the teacher should provide reason for rejection so that learners can understand their mistake.
Learner Specific

FR3.1. Learners can choose learning paths from the ones published by the teachers. (Freedom of Choice).

FR3.2. Learners can also create their own learning path.

FR3.3. Learners have to manually choose a learning path for each course section.

FR3.4. The only way for a learner to qualify a section is either by fulfilling all criteria of a learning path they are following or by finishing all materials from the section.

FR3.5. Learners can view their progress through the course sections.

FR3.6. Learners can follow more than one learning path for a section. The path they complete will be the one that will be selected for them for that section in the progress report.

Common to both set of users

FR4.1. A separate feature to display graphs, charts and other visual analytics for both learners and teachers giving insight on course resources and learning paths.

4.4 Non-Functional Requirements

With the functional requirements of the plugin defined, in this section non-functional requirements of the plugin will be discussed. Non-functional requirements define the quality attribute of the plugin. Since the plugin is integrated into a larger system—Moodle installation—the discussion will be restricted to requirements specific to the plugin and not the ones concerned with the larger system.

Performance Requirements

NFR1.1. Navigation within the plugin should be fast (i.e. not more than 5 seconds)
NFR1.2. Waiting time for graph rendering should not exceed 30 seconds
NFR1.3. Data submission through Moodle forms should be fast (i.e. not more than 5 seconds)
NFR1.4. Data retrieval should be fast (i.e. not more than 5 seconds)

Security Requirements

NFR2.1. The learners won’t be able to view learning paths for a section higher than their highest incomplete section.
NFR2.2. Data stored in the database should be secured
NFR2.3. Plugin should conform to Moodle Security guidelines

Software Quality Attributes

NFR3.1. Code has to be self-explanatory
NFR3.2. Plugin should have a clean code design
NFR3.3. Plugin has to be developed in a modular way to ensure interoperability
**Coding Standard**

NFR4.1. Plugin code should maintain the Moodle coding style
Chapter 5  Software Design

With the requirements defined, the next step in the development process was to design the plugin. This chapter begins by identifying the important use cases of the plugin and presents a cumulative diagram depicting them. Thereafter, it introduces the design principles followed and eventually leads to the software architecture where the important concepts, functions of standard files of Moodle development and APIs (both core and external) are discussed.

5.1 Users and Use Cases

There are several different actions possible when using the ‘Learning Strategizer’ plugin. The two main use cases of the plugin are

(1) Teachers adding and publishing learning paths and the consequent selection of the published learning path by a learner

(2) Creation of a learning path by a learner abiding by rules set by teachers and its corresponding approval or rejection by teacher.

Apart from these, the teachers and learners can together view statistical data and learners can track their progress through a course.

Use Case 1: Addition and publication of paths by teachers and consequent selection by learners

Teachers can define learning paths that the students can choose to follow. Each learning path that the teacher creates is for the entire course covering all sections. The teacher provides name and description of the path and selects course materials to be included in that path. Teachers can review, edit or delete the path after creation. Once they are satisfied with the structure of a path, they can publish it. Once published, the path becomes available to learners and cannot be further modified by the teacher. Learners can view and choose from published learning paths. Learners view learning paths of their highest incomplete section from the course only. They can view what are the constituents of each of the learning path of that section and then select according to their preference.

Use Case 2: Creation of paths by students and corresponding approval/rejection by teachers

In case the students don’t like any of the published learning paths for a section they can choose to create their own. There are rules set by teachers to make sure that the students build effective learning paths. These rules may include conditions or actual learning materials. The learning materials stated in the rules get auto included in the learning path that the learner creates. Once the learner has created a learning path, it goes to the teacher for approval. This is done in order to verify if the learner’s path abides by the conditions set in the rules and to also check for other discrepancies. The teacher approves or rejects the path and in case f the latter the teacher needs to provide a rejection reason. The learners can track their path request to check whether their path has been approved, rejected or still awaiting action from the teacher.

Remaining Use Cases: Visual statistics for learner and teachers and progress tracking for learners

Learning Strategizer provides a visual statistics module to both teachers and students that allows them to visualise important data from the course such as which are the important resources, which learning paths are chosen most by students etc. The plugin also provides, for learners, a milestone view to track their progress through the course where each of the course section is a milestone.
Figure 5 Use case diagram including all use cases related to Learning Strategizer with primary actors (teacher and student) on the left and the secondary actor (Moodle) on the right hand side.
5.2 User Interface Design
The design of ‘Learning Strategizer’ was developed in accordance to the below two sets of guidelines:
- Ten Golden Rules of Interface Design
- Gestalt’s Laws

The ‘Ten Golden Rules of Interface Design’ serve as general guidelines in terms of UI best practises. The rules are as follows [59]:

<table>
<thead>
<tr>
<th>Rule</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Keep the interface simple</td>
</tr>
<tr>
<td>2.</td>
<td>Speak the user’s language</td>
</tr>
<tr>
<td>3.</td>
<td>Be consistent and predictable</td>
</tr>
<tr>
<td>4.</td>
<td>Provide feedback and be responsive</td>
</tr>
<tr>
<td>5.</td>
<td>Minimize memory load</td>
</tr>
<tr>
<td>6.</td>
<td>Avoid errors, help to recover, offer undo</td>
</tr>
<tr>
<td>7.</td>
<td>Design clear exits and closed dialogs</td>
</tr>
<tr>
<td>8.</td>
<td>Include Help and documentation</td>
</tr>
<tr>
<td>9.</td>
<td>Address diverse user needs</td>
</tr>
<tr>
<td>10.</td>
<td>Hire a graphic designer</td>
</tr>
</tbody>
</table>

Table 4 Ten Golden Rules (GR) of Interface Design adapted from [59]

Gestalt’s laws are a set of principles describing how humans typically view objects by grouping similar elements, recognizing patterns and simplifying complex imagery. Developed plugin followed some of the most widely recognized Gestalt’s laws. The laws followed are:
- **Proximity Law (GLPL):** Spatially close objects or events are perceived to belong together
- **Similarity Law (GLSL):** Similar shapes are perceived to belong together
- **Experience Law (GLEL):** Humans tend to categorize new things into groups they already know. They use existing knowledge or experience to learn thus saving effort and memory

The user interface of ‘Learning Strategizer’ has been kept straight-forward (GR1) and pages offering similar or related functions are adjacent to each other and are designed the same way (GR3, GLSL, GLPL). Prompts are provided frequently telling the learner or teacher what to do (GR4). All pages involved in the plugin has a navigation bar in its header that provide clear exits from the plugin processes to the course home page and the user dashboard (GR7). A separate module of the plugin provides information about the available functions of the plugin based on who’s using it—learner or teacher (GR8). Navigation between pages related to an operation is offered through a horizontal array of tabs, which is derived from the idea from having several tabs on a single browser window while surfing (GLEL) [60].

5.3 Software Architecture

In this section, the overall software architecture is presented and discussed. The basic concepts related to Moodle, standard files associated with general Moodle plugins are described briefly followed by Learning Strategizer specific tables, their schema and finally their relationship with each other and core Moodle tables.

5.3.1 Plugin Type

There are different types of Moodle plugins. Initially, the Learning Strategizer was conceived to be an activity module type. Activity module plugins serve as activities in the course. However, making it an activity module plugin meant that the student performed the action once. The scope of learners changing their path within a section wasn’t supported efficiently with that plugin type. Hence, the Learning Strategizer was decided to be a block type plugin so that it could be standalone and both teachers and learners could revisit it at any point in the course.
5.3.2 Important concepts and files

There are several standard function, concepts and files that Moodle requires to be defined by the developer for the proper functioning of a plugin. This section discusses them and explains their definition in terms of the Learning Strategizer.

5.3.3.1 Roles, Capabilities and Permissions

Role identifies a user’s status. In case of Learning Strategizer there are two roles—teacher and student(or learner). A capability is a description of a particular Moodle feature. Capabilities are associated with roles. A permission is some value that is assigned for a capability of a particular role. The Learning Strategizer module specifies four custom capabilities (in db/access.php):

- addinstance - allows user to add a 'Learning Strategizer’ block to a course page
- myaddinstance - allows user to add a 'Learning Strategizer’ block to their dashboard
- viewpages - allows user to view pages.
- managepages - allows user to edit and manage the pages of the block

The last two capabilities differentiate between teachers, course managers, course creators and learners. All users have ‘viewpages’ capability but learners and guests don’t have ‘managepages’ capability. This capability differentiates between learners and teachers.

5.3.3.2 Tables

The Learning Strategizer has 7 tables of its own (defined in db/install.xml). The XML file, containing table definitions) is used on installation of the plugin and creates the associated tables according to the definition provided. For each block, the database must have a main table with the same name as that of the block itself. The tables specific to Learning Strategizer are as listed in Table 5. Figure 6 and Figure 7 illustrate the relations these tables have among themselves and the relations of these tables with Moodle core tables.

<table>
<thead>
<tr>
<th>Table Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>block_learning_strategizer</td>
<td>Default for block Learning Strategizer</td>
</tr>
<tr>
<td>ls_basic</td>
<td>Table contains name and description of learning paths</td>
</tr>
<tr>
<td>ls_path_details</td>
<td>Table contains details of created learning paths</td>
</tr>
<tr>
<td>ls_path_user_staging</td>
<td>Table contains the pending learning path approval details</td>
</tr>
<tr>
<td>ls_path_user_approved</td>
<td>Table contains the approved learning path details</td>
</tr>
<tr>
<td>ls_path_user_rejected</td>
<td>Table contains the rejected learning path details</td>
</tr>
<tr>
<td>ls_path_section_rules</td>
<td>Table containing rules set by teachers for sections</td>
</tr>
</tbody>
</table>

Table 5 Associated Tables of Learning Strategizer
Amrita Deb - Use of Gamification as a support for strategizing in Self-Regulated Learning
5.3.3.3 Lang Folder (in db/lang)
Moodle is multilingual, and it extends this feature to its plugins as well. The Lang folder is where the developer ideally stores all the strings that the plugin uses. Each language has a specific folder that needs to be created for it to be used with Moodle. The ‘Learning Strategizer’ provides for only one language – ‘English’—and hence it has a single folder named ‘en’ (short for English) under the lang folder. The ‘en’ folder contains a single PHP file having the same name as that of the block plugin (block_learning_strategizer.php). This file lists the translations of all string used by the plugin.

5.3.3.4 Class File (block_learningstrategizer.php)
This file holds the class definition for the block and is used to both manage it as a plugin and to render it on screen. The first line is the class definition which extends another class block_base. This is a Moodle base class from which all blocks derive. Within the class definition of 'Learning Strategizer' there are two methods—\texttt{init()} and \texttt{get\_content()}

- \texttt{init()}: This method is essential for all blocks. It provides values to any class member variable that needs instantiating. In ‘Learning Strategizer’, the method sets \texttt{$this->title} which is the title in the header of the block fetched from the language file mentioned before. No return value is expected from this method.

- \texttt{get\_content()}: this method populates the \texttt{$this->content} variable which holds all the actual content displayed in a block. Valid values for it are either \texttt{NULL} or an object of class stdClass. Normally it begins with a value of \texttt{NULL} and gradually becomes fully constructed when \texttt{get\_content()} is called.

5.3.3.5 version.php
This file holds the version information for the plugin and the name of the block. Information is provided by filling attributes of stdClass object called \texttt{$plugin}. The version file of 'Learning Strategizer' is simple containing few field definitions as below:

- \texttt{$plugin->version} is an integer number in a format that is commonly used across Moodle for versioning. It is of the format YYYYMMDDXX where YYYY, MM, DD denote the year, month and date respectively. The last two digits at the end ’XX’ can be used for releasing many versions in one day or for maintaining several branches of the plugin.

- \texttt{$plugin->component} is the name of the block in frankenstyle naming convention of the format plugintype_pluginname. In 'Learning Strategizer’ it is defined as 'block learning strategizer’.

- \texttt{$plugin->requires} is an integer number that specifies the minimum version number of Moodle core that the plugin requires.

5.3.3 APIs

5.3.3.1 Core APIs
The Learning Strategizer utilizes the below core Moodle APIs.

- \texttt{Form API}: Web Forms in Moodle are created using this API. Form API supports all html elements (checkbox, radio, textbox etc), with improved accessibility and security [61]. Since Learning Strategizer requires user input and submission of data, this API is used extensively throughout the plugin.

- \texttt{Navigation API}: This allows for the manipulation of the navigation system used in Moodle. Navigation is available through the page object $PAGE, against which the heading for the page, the title, any JavaScript requirements, etc. is set [62]. The Learning Strategizer has a navigation bar in the header of each page which serves as exits to the Dashboard or course main page(Gr7).
• **Data definition API:** This holds available functions under Moodle that handles DB structures (tables, fields, indexes, etc.). The API provides a well-defined group of functions to manage all DB structure (DDL statements) using one neutral description, executes correct SQL statements required by each RDBMS [63].

• **Data manipulation API:** This holds exclusive functions to retrieve or modify database content that provide high level of abstraction and ensure that data manipulation works against different RDBMs [64]. Learning Strategizer deals extensively with databases and hence these two APIs are useful

### 5.3.3.2 External APIs

• **Google Charts API:** A module of the Learning Strategizer plugin was dedicated to providing visualized statistics to both learners and teachers. The Moodle plugin directory didn’t provide any suitable plugins that could fully encompass the requirements. Thus the module was eventually developed using the Google Charts API. Google Charts API is an interactive Web service that creates graph-charts based on user-supplied data. The API provides various chart forms such as pie, scatter, column, histograms etc. The objective of the module is to provide graphs that will offer insight on the below preliminary questions
  - Which resources are most included in learning paths?
  - Which learning paths are popular among students?
  - Are students being able to complete resources marked mandatory?
  - Are students being able to complete resources not marked mandatory?

Since graphs to answer these questions required data mostly from custom plugin tables, the Google Charts API was a better choice compared to plugins from the Moodle directory.

• **Google Fonts API:** The API is a free web service allowing web developers to utilize other fonts outside of the Web-safe fonts cadre in a resource-efficient way. Learning Strategizer uses Google Fonts API to enhance the interface texts.
Chapter 6  Implementation

This chapter elaborates on the implementation of the plugin. The discussion is divided into two parts based on the two user classes—teacher module and student module. The various operations provided by the plugin to the two roles are discussed, in detail, on a technical as well as functional level.

6.1  Teacher module

The Teacher specific functional requirements was reviewed and based on that, the teacher module of the ‘Learning Strategizer’ was decided to have three primary operations:

- **Add Learning Path**: lets teacher define, edit, delete and publish Learning Paths. This has also provisions to set additional rules that students who make their own Learning Path must abide by.

- **Pending Approval**: lets teacher review requests of custom Learning Paths made by students, approve them or reject them stating appropriate reason.

- **View Stats**: presents graphical information regarding various aspects of the Learning Paths associated to the course.

In addition, there is also a ‘Help’ feature that will inform the teachers about the functionalities and how to use the plugin.

The three primary operations will be described in detail in the following sections.

6.1.1  Operation 1: Add a Learning Path

Once a teacher clicks on Add Learning Path option from the main view of the block, they are taken to the ‘Define Learning Path’ page. The header section of the page contains the plugin name and a navigation bar. The navigation bar serves as exit and provides link to the course main page and Dashboard, in case the user wishes to leave the plugin page (GR7).

After that the plugin provides an array of tabs. Each of these tabs links to a Moodle form. The available tabs and their brief description are as below:
• **Define learning path**: Allows teachers to create learning paths by providing name, description and course modules to include from each section

• **Set rules**: Allows teachers to provide additional rules for learners who wish to make their own learning paths

• **Review Learning Path**: Allows teachers to view published and non-published learning paths

• **Edit Learning Path**: Allows teachers to edit unpublished learning paths

• **Delete Learning Path**: Allows teachers to delete unpublished learning paths

• **Publish Learning Path**: Allows teachers to select and publish unpublished learning paths

*Define Learning Path* This is the starting page for ‘Add Learning Path’ operation where the teacher can create learning path for the learners. The page calls upon a Moodle form ‘learning_strategizer_form’ since it requires to retrieve values user enters.

The form contains text fields for the teachers to provide the name and description of the learning path. The name is a required field and the form will not get submitted if there is no value given. The description field can be used to provide some hints to the students on the type of learning path or its target group. The ‘Name’ and ‘Description’ field values are transferred to the ‘ls_basic’ table. It is important to remember, at this point, that when teachers create a learning path, they have to do so for the whole course. Thus, beyond the name and description fields are a number of collapsibles equal to the number of sections in the course. The title of these collapsibles is the name of the course section and on expansion, these generate a list of course modules included within that course section. Each of these course modules have two checkboxes ‘Include’ and ‘Required’ associated with it. The concept behind these is to differentiate between mandatory and non-mandatory materials. When a course module is marked ‘Required’, they become auto included in the learner created learning paths. The plugin selects distinct ‘Required’ course modules for a course section across Learning Paths and make them mandatory materials. If now a student wishes to create their own learning path for that section, these modules become a part of their path automatically and the student can only choose to include modules that are not marked ‘Required’. Thus, the logic of ‘Learning Strategizer’ requires mandatory course modules to be constant throughout a course i.e. the same modules should be marked as ‘Required’ in all learning paths associated with a course. If this is not maintained, it can overload and eventually include all materials from a course as mandatory, which is not desirable.

On submission, this form inserts the marked course module information in the ‘ls_path_details’ table with the value of field ‘published’ as 0. It also generates a color-coded hierarchical view of the Learning Path. The teacher can view and match it with their input since the form will also be there below the hierarchical view with the values provided by the teacher. The ‘Required’ course modules are presented in red while the ‘Include’ marked are presented in blue. The modules are separated in sections for better visualization.
Figure 9 Define Learning Path from Teacher View of ‘Learning Strategizer’ block

Figure 10 Course Section Collapsible
**Set Rules** This tab lets the teacher add additional restrictions on section for learners who wish to create their own learning paths. In addition to the mandatory course modules, the learners need to abide by these specified rules as well. These rules can be completing additional modules from the section or something beyond the course materials viz. finishing a book report or doing a presentation.

The page calls upon a Moodle form ‘setrules_form’. Like ‘Define Learning Path’ this form also has collapsible equal to the number of course sections with titles same as that of the course sections(GR3). On expansion of each these collapsible, a list of distinct ‘Required’ course modules from that section is displayed. This prompt provides an opportunity to the teacher to correct the paths, if paths are unpublished. After the prompt, there are two dropdowns with captions ‘No of Module’ and ‘Module Name’. Module Name lists the distinct course module types(resource or quiz or assignment etc.) available in that section and by choosing a number from ‘No of Module’ the teacher can add the constraint of how many of that selected module type the learners must complete from that section in addition to the ‘Required’ course modules listed in the prompt. There is also a text field provided to specify some additional custom activity (within or outside the scope of the course materials). Rules for a section can only be set once so teachers must be careful and plan accordingly.

On submission, of the form, data related to these rules will be inserted into ‘ls_path_section_rules’ table. When a learner wants to create a learning path they will receive a prompt stating the rules for that section and required course modules.
Set Rules for student defined paths

This page allows you to set some additional rules that students have to follow for each section while creating their own Learning Path. These additional rules will be enforced alongside inclusion of required modules from each section.

The setup for a section cannot be changed once a student has submitted a request for that section.

**Types of Pasta**

The required modules from this section is:

- QUIZ: Types of Pasta
- BOOK: Pasta Origins

<table>
<thead>
<tr>
<th>No of Module</th>
<th>Module Name</th>
<th>Describe the additional custom activity, you wish to enforce</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>resource</td>
<td>Book report on Pasta Origins</td>
</tr>
</tbody>
</table>

Figure 12 Example of setting additional rule for a section in Learning Strategizer

Set Rules for student defined paths

This page allows you to set some additional rules that students have to follow for each section while creating their own Learning Path. These additional rules will be enforced alongside inclusion of required modules from each section.

The setup for a section cannot be changed once a student has submitted a request for that section.

Rules have already been set for Section 1 of this course. You cannot have multiple rule for some section in a course.

**Types of Sauces**

The required modules from this section is:

- ASSIGN: Make a Pasta Sauce
- WORKSHOP: Pasta Sauce Workshop

| No of Module | |
|--------------||

Figure 13 Rules for a section can be set only once
Review Learning Path  This tab offers teachers to view all the learning paths in the system. This includes published, unpublished learning paths along with student created learning paths (path name starting with ‘custom’) that have been approved by teacher. The page calls upon a Moodle form named ‘reviewpath_form’ which contains a list of collapsibles with titles same as learning path names. On expansion of each of these collapsible, the detailed path is displayed in the same colour coded hierarchical format as described in ‘Define Learning Path’ (GR3, GLSL, GLEL). This tab is for reviewing purpose only and doesn’t offer any modification functionalities. The teacher can modify or delete a learning path, provided the path is unpublished. The tabs ‘Edit Learning Path’ and ‘Delete Learning Path’ offers this opportunity.
Edit Learning Path This tab allows teachers to change or modify learning paths that have not been published yet. Once a Learning Path is published, it cannot be edited. The page calls upon the Moodle form called ‘editpath_form’ which lists all the unpublished learning paths. Only one learning path can be edited at a time. The teacher selects the learning path they wish to modify and click Edit. A form containing list of collapsibles corresponding to course sections like in ‘Define Learning Path’ is generated to maintain interface consistency and avoid confusion(GR3,GLSL,GLEL). The teacher must mark course modules again for each section and submit the plan. The new course module information is updated in the ‘ls_path_details’ table.
Delete Learning Path This tab allows teachers to delete a learning path as a whole. Only unpublished learning paths can be deleted. The page calls upon the Moodle form ‘deletepath_form’ which lists the distinct unpublished learning paths. The Learning Strategizer provides teachers to delete more than one learning path at a time. The teacher needs to mark the learning paths they wish to delete and click submit. All related details regarding the selected learning path will be deleted from both the ‘ls_basic’ and ‘ls_path_details’ table. Once a learning path is deleted it cannot be recovered, hence teachers need to be careful while executing the deletion operation.
Publish Learning Path This tab allows teachers to publish learning paths they created in ‘Define Learning Path’ tab. The page is designed similar to ‘Delete Learning Path’ to maintain interface consistency (GR3, GLSL, GLEL). The Learning Strategizer offers teachers to publish more than one learning path at a time. The page calls upon a Moodle form named ‘publishpath_form’ which lists all the distinct unpublished learning paths with checkboxes attached to them. The teacher needs to mark the paths they wish to publish and click Edit. The form will update the ‘published’ field in the ‘ls_path_details’ table for that learning path to 1, which signifies that the learning path has been published. The teacher receives a prompt that the path(s) has been published and is/are now available to learners. Apart from that, the teacher can also verify the status of the learning path(s) from the ‘Review Learning Path’ tab, where the learning path will now be listed under ‘Published Learning Path’. Only paths that are published, will be available to learners and a published path will not be available for further modification or deletion.

<table>
<thead>
<tr>
<th>Define Learning Path</th>
<th>Set Rules</th>
<th>Review Learning Path</th>
<th>Edit Learning Path</th>
<th>Delete Learning Path</th>
<th>Publish Learning Path</th>
</tr>
</thead>
</table>

Publish Learning Path

Choose the Learning Path you wish to publish

Please remember choosing this will make the chosen Learning Path(s) available to students. You won't be able to modify the paths after publishing. If you wish to change some modules of a Learning Path go to the Edit tab

- [ ] Learning Path 2712 - Learning Path aimed at Visual Learners
- [ ] Lp23 - Here is another common Learning Path

Submit

Figure 19 Publishing a path from ‘Publish a Learning Path’ tab

6.1.2 Operation 2: Pending Approvals

When the teacher clicks on the ‘Pending Approval’ link from the main view of the plugin, they are taken to the page where requests from learners’ learning paths are listed. Like ‘Add a Learning Path’, the header section holds the name of the plugin along with a navigation bar with links to the dashboard and course main page, that acts as clear exits from the flow of the plugin processes (GR3, GR7). After that, the page presents an array of two tabs—‘Pending Approval(s)’ and ‘Resolved Approval(s)’.

Pending Approval(s) This tab lists requests from students, who wish to follow and therefore have built, their own learning path for a section. The page calls a Moodle form pendingapproval_form which presents the requests in tabular format. The table displaying the list of requests has 5 columns. The first column, named Request ID, numbers the requests chronologically in first come first serve basis. The second column, named ‘Path Name’ states the learning path name. Student created learning paths are named in the format ‘custom_<userid>_<path name the student gave>_<courseload>_<sectionid>’. The ‘userid’ is fetched from Moodle’s core table ‘users’ and ‘sectionid’ is the id of the section, for which the student created the path, according to Moodle’s core tables ‘course_sections’ and ‘course_modules’. The third and fourth columns, named ‘Student Name’ and ‘Student ID’, holds the name and id of
the student respectively. The id and name of the student is fetched Moodle’s core table ‘users’. Finally, the fourth column, named ‘Section’ is the id of the section, for which the plan is.

The ‘Path Name’ column entry also serves as a link with which the teacher can view the student’s learning path structure. This path structure follows the same color-coded hierarchical design, discussed for teacher defined learning paths, to maintain interface consistency (GR3, GLEL, GLSL).

The Learning Strategizer allows the teacher to approve or reject more than one request at a time. Each learning path requests has a checkbox associated with it. Above the table there is a row with the choice of functions—approve or reject. The teacher can mark the associated checkbox of learning paths they wish to approve and hit Submit. This will assign the chosen learning path to that user for that course section. In backend, this is established by transferring the details from ‘ls_path_user_staging’ to ‘ls_path_user_approved’ and ‘ls_path_details’ tables. Similarly, for rejection, the teacher can mark the learning paths, choose ‘Reject’ and click Submit. In this case, they are redirected to the ‘Rejection Reason Clarification’ page where they are required to provide a reason for their rejection of the path so that the student knows why their path was rejected. The text field for providing the reason is a mandatory one and the plugin will not allow rejection without it. The page provides a link to go back to the ‘Pending Approval’ page in case the teachers change their minds. Once the teacher provides a reason and submit. The path is rejected for that student and course section. In backend, this is done by transferring the information from ‘ls_path_user_staging’ to ‘ls_path_user_rejected’ table.

<table>
<thead>
<tr>
<th>Request ID</th>
<th>Path Name</th>
<th>Student Name</th>
<th>Student ID</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>custom_5_Ronald’s Plan_1</td>
<td>Ronald Weasley</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>custom_8_Bridget Plan_1</td>
<td>Bridget Jones</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>custom_3_PotterPlan_2</td>
<td>Harry Potter</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

Figure 20 List of student learning path requests in ‘Pending Approval(s)’ tab

Figure 21 viewing the structure of a student learning path from the link in Path Name
**Resolved Approval(s)** This design of the page under this tab follows that of ‘Pending Approval(s)’ and is centered around a table (GR3,GLSL,GLEL). The table lists prior requests that have been resolved i.e. either approved or rejected. The table has 6 columns. The first column, named Request ID, numbers the resolved requests chronologically in first come first serve basis. The second column, named Path Name, states the name of the student created learning path and is of the format ‘custom_<userid>_<path name the student gave>_<courseid>_<sectionid>’ (discussed in Pending Approval(s)). The Path Name column, like in ‘Pending Approval(s)’, provides a link for the teacher to view the structure of the learning path. The third, fourth and fifth columns, named Student Name, Student ID and Section respectively, states the same information as they did in the ‘Pending Approval(s)’ tab. The final column, named Result, states whether the path has been approved or rejected by the teacher.

<table>
<thead>
<tr>
<th>Request ID</th>
<th>Path Name</th>
<th>Student Name</th>
<th>Student ID</th>
<th>Section</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>custom_2_My Plan for sec2_2</td>
<td>Amrita Deb</td>
<td>2</td>
<td>2</td>
<td>Approved</td>
</tr>
<tr>
<td>2</td>
<td>custom_2_Section Plan_2</td>
<td>Amrita Deb</td>
<td>2</td>
<td>2</td>
<td>Rejected</td>
</tr>
<tr>
<td>3</td>
<td>custom_3_PotterPlan_2</td>
<td>Harry Potter</td>
<td>3</td>
<td>2</td>
<td>Approved</td>
</tr>
</tbody>
</table>

**Figure 23 List of learning paths request that have been approved or rejected from 'Resolved Approval(s) tab**
6.1.3 Operation 3: View Stats

When the teacher clicks on the ‘View Stats’ link from the main view of the page, they are taken to the Visual Analytics feature of the plugin. Currently this feature is same for both teacher and learner but it can later be extended to include different charts catering to the specific role. In this thesis four analytics are provided in this feature. They are as follows:

- **Popular Non-Required Resources in Learning Paths**

![Pie chart showing popular 'Non-Required' Resources in Learning Paths](image)

This chart presents a pie chart of top 10 course modules that are not marked ‘Required’ in learning paths. On hovering the mouse over to the part highlights the name of the module along with the number of learning paths where it has been marked as ‘Included’ and not ‘Required’. In backend these are the course modules with inc=1 and req=0 in ‘ls_path_details’ table. This chart helps to identify which course modules are important among the “Non Required” modules.

- **Popular Learning Paths among students**

This chart presents a column chart listing the learning paths being chosen by learners. The X axis states the name of the learning path and the Y axis states number of students. On mouse hover, each columns of the chart gives the name of the path along with the number of students choosing it. In backend this is the distinct learning path ids along with the count of user ids associated with it in ‘ls_path_user_approved’ table. This chart also lists custom paths since an approved student created learning path becomes available as an option in the list of learning paths students can choose from. This chart helps teachers to understand what learning paths are popular among students which can, in consequence, provide insight about what the students prefer.
**Figure 25** Column chart showing the popular Learning Paths among students

- **Required Resources and the number of students completing them**
  
  This column chart displays the course modules marked ‘Required’ across learning paths and the number of students who have completed them. The X axis lists the name of the ‘Required’ course modules and the Y axis is the number of students. On mouse hover, each column shows the name of the ‘Required’ module and the number of students that have completed it. In backend, this is built in two folds. At first, the ‘Required’ module list is extracted from ‘ls_path_details’. After that, for each of these modules the count of users who have completed it is extracted from the Moodle core table ‘course_modules_completion’. This can give the teachers an idea about which ‘Required’ modules, students are finding hard and which are reasonably doable.

**Figure 26** Column chart showing the 'Required' modules across Learning Paths and the number of students who have completed it
Non-Required Resources and the number of students completing them

Similar to the previous chart, this column chart displays non-required course modules across learning paths and the number of students completing them. The chart is built in two folds similar to ‘Required’ Resources and the number of students completing them’ where, at first, the non-required course modules from the different learning paths are extracted and then, count of users completing them from Moodle’s core table ‘course_modules_completion’ is generated. This chart can help teachers understand which ‘non-required’ course modules, students are finding difficult to complete and what are reasonably doable.

Figure 27 Column chart showing course modules marked 'Included' across Learning Paths and the number of students completing it

6.1.4 Operation 4: Help

The ‘Help’ feature of the plugin gives a brief description of the ‘Learning Strategizer’ and its origin which is the research question (stated before).

Based on the user’s role, i.e. whether it’s a teacher or a student, this page then lists the functions the user can do with the help of the plugin.

For a teacher, the list is as follows:

- Define Learning Path which becomes pre-defined Learning Paths that students can choose to follow.
- Set extra rules or constraints that students making custom Learning Paths must follow
- Edit the Learning Plans they created in (1.) before Publishing
- Delete any of the Learning Paths they created in (1.), provided they are not published
- Publish a Learning Path so that it is available to students
- Approve a Learning Path submitted by a student
- Reject a Learning Path submitted by a student citing reason.

6.2 Student module

Similar to the development of the teacher module, the implementation of the student module began with the review of the learner specific functional requirements of the plugin. Based on the extracted functions, the
learner module of the ‘Learning Strategizer’ was decided to have the below primary operations:

- **View Learning Paths** lets learners choose their learning path from available teacher defined paths
- **Create Learning Paths** lets learners create their own learning path
- **View Stats** presents graphical information regarding various aspects of the learning paths associated to the course
- **Track My Requests** lets learners track the requests of the self-created learning paths
- **View My Progress** presents a timeline view of the learner’s progress in the course

Similar to the teacher’s module, there is also a ‘Help’ feature available for students that informs them about the functionalities and how to use the plugin.

6.2.1 Operation 1: View Learning Paths

Once a learner clicks on the ‘View Learning Paths’ option from the main view of the block, they are redirected to the page from which they can review and choose a learning path for themselves. It is required to remember at this point that students choose their learning paths manually and for every section of the course. When a student arrives at this page, it lists available learning paths for the highest incomplete section. The page is divided into two parts. The first part lists the names of available paths for that section. Each of the learning path is associated with a radio button (since a learner can choose one learning path at a time). The second part of the page illustrates the structure of the learning paths listed in the first section. The learning paths are presented as collapsibles, expanding them display the structure of the learning paths. The structure follows the similar hierarchical color-coded format as discussed in the teacher module to maintain interface consistency (GR3, GLSL, GLEL). The idea is for students to check the course modules associated with each available path and choose one they find suitable. Learner created learning paths approved by teachers are also included in the list of available paths. When learner chooses a path, in backend, this information is transferred to ‘ls_path_user_approved’ table. (*Figure 29*)
The field ‘completed’ in the ‘ls_path_user_approved’ table indicates whether a learning path for a section has been completed by the learner. After selection of a path, whenever they wish to see their progress from ‘View My Progress’ or choose a learning path from ‘View Learning Paths’ or create their own from ‘Create Learning Paths’, the plugin runs a check to see the completion status of the paths they are following. If the learner has completed all the modules of their learning path the plugin updates the ‘completed’ field to 1. Since the table records the course and course section information as well, the plugin checks the highest number of sections for which there is a path for the student whose ‘completed’ field value is ‘1’. The highest section derived this way and incrementing it by 1 gives the highest incomplete section (provided the number doesn’t exceed the number of course sections of the course). The flowchart representation of the routine followed by the plugin to check the highest incomplete course section and how a section is marked complete is given in.

$section=$DB->get_records_sql("select max(section)as highest  
    from {ls_path_user_approved}  
                      ...                                   and userid=$USER->id  
                                           and completed='1'");

Figure 29 'View Learning Paths' page

Figure 30 Highest completed course section
6.2.2 Operation 2: Create Learning Paths

If the learner doesn’t like any of the learning paths available in the ‘View Learning Paths’, they can opt to create their own by clicking ‘Create Learning Paths’ option from the main view of the plugin. The page design is similar to ‘Define Learning Path’ but on a single section level. The page header has the plugin name and the navigation bar with links back to the dashboard and the course main page to provide clear exits for the student if they wish to leave the plugin page (GR7). The learning path that the student creates is based on the course section hence the plugin first needs to calculate the highest incomplete course section within bounds of the total number of course sections. The plugin
follows the routine described in to do this. Once that is calculated, the page body can be divided into three parts. The first part provides fields for student to enter name and description of the path. The Learning Path Name field is a mandatory one and the form will not get submitted until the learner has provided a value for it. The second part displays the name of the highest incomplete course section followed by the mandatory modules or rules set by teachers for that section (6.1.1.). The final part of the page body lists the non-required course modules, each associated with a checkbox named ‘Include’. The required course modules and rules are auto included in the learning path for that section. In addition, the students choose from the listed ‘non-required’ course modules what they want by marking the checkbox and clicking Submit. On form submission, first the name and description of the student defined path is transferred to the ‘ls_basic’ table and an id for the learning path is generated. The learning path name is recorded in the format \texttt{custom\_<userid>\_<path name student gave>\_<courseid>\_<sectionid>}. The details of the learning path contents are transferred into ‘ls_path_user_staging’ table with the value in ‘published’ field as ‘-1’.

![Create your custom path for Section 2](image)

Figure 32 'Create Learning Paths view of 'Learning Strategizer' block

6.2.3 Operation 3: View Stats

The ‘View Stats’ operation for both student and teacher modules is currently the same. The option provides graphical information about:

- Popular Non-Required resources in Learning Paths
- Popular Learning Paths among students
- Required Resources and the number of students completing them
- Non-Required Resources and the number of students completing them

The associated graphs have already been described in detail in 6.1.3.
6.2.4 Operation 4: Track My Requests

This page lists all the learning paths that the learner has ever created within the course along with its’ status. The learning paths that have been approved are marked in green, the rejected learning paths are marked in red and includes the reason provided by the teacher. Finally, the requests that are still waiting for a teacher’s action will be marked in yellow with appropriate prompt message.

![Learning Strategizer](image)

**Figure 33** Track My Requests view of the 'Learning Strategizer' block

6.2.5 Operation 5: View My Progress

This page shows a milestone view of the progress of the learner in the course. The page content is a vertical milestone line with rectangular milestone boxes. Each of the milestone box represents a course section of the course and contains information about the learner’s progress in that section. The progress of the learner is calculated through a routine which is similar to Figure 31 but instead of calculating the highest incomplete section, it calculates progress in individual section. Each of the milestone box has a text portion and a progress bar. The progress bar gives a visual of how much of the course section is done while the text provides details such as the path the learner is following for that section and how many of the course materials are done.
6.2.6 Operation 6: ‘Help’

The ‘Help’ operation for the learner module serves the same purpose as it did for the teacher module (6.1.4) i.e. providing a brief description and origin of (research question) ‘Learning Strategizer’ along with the list of functions the plugin allows for the student.

For a learner, the list is as follows:

- Select a Learning Path from a list of carefully tailored pre-defined Learning Paths created by teachers
- Change or stay on a Learning Path for a follow-up section based on your self-reflection phase analysis
- Create your own Learning Path in case you don’t like any of the pre-defined paths from the teacher
- View progress within the course
- View popular Learning Paths and resources that your fellow course mates are following and completing
Chapter 7 Evaluation

A project aimed to explore the essence of program evaluation found that evaluation helps to identify [65],

- accountability of program performance and expenses
- improved decisions about program direction, resource allocation, design, implementation, management efficiency and evaluation
- increased understanding of requirements, increased capacity of design, assessment and improvement
- public opinion
- increased collaboration between stakeholders and development team

In this chapter the usability study conducted to evaluate the plugin has been discussed. The evaluation techniques used and test environment are described followed by the process of selection of users and the list of tasks. The chapter concludes with a discussion on the study results and observations.

7.1 Evaluation Technique

Evaluation Techniques, adapted from [66], are listed in the figure below:

![Evaluation Techniques classification](image)

The methods chosen for evaluating the Learning Strategizer is a combination of ‘Silent Observation’ and ‘Think Aloud’ and ‘Retrospective Testing’.

Silent Observation is a qualitative evaluation technique with users. During the evaluation, following this technique, the developer silently observes the user working on the tasks. There is no communication between them during this [66].

Think Aloud is also a qualitative evaluation technique involving users. This is similar to ‘Silent Observation’ but the users are asked to speak their mind about,

- what they think is happening (state)
- what they are trying to achieve (goals)
- why they are doing something specific (actions)
A drawback of ‘Think Aloud’ evaluation technique is participants are not always comfortable in keeping up the required monologue [67]. For such cases, Retrospective Testing technique was used to understand why the users did what they did. Retrospective testing adds an additional step where the user and developer revisit the action the former has done, and they are asked to comment on their actions retrospectively [66].

### 7.2 Test Course and Participants

A test Moodle site “Past Schnitzel” and a test course “How to make Pasta” were created to test and evaluate the functionality of the plugin. Alongside the automatic course creator, 13 user profiles were created–one of them was a teacher (Albus Dumbledore) and the rest were students. There were 4 main sections based on 4 topics – ‘Types of Pasta’, ‘Types of Sauces’, ‘Addon Proteins’ and ‘Health Details’. Each section had some resource or activities associated with it. The types of course modules included in the test course are files, assignment, quiz, book, URL and Workshop.

![Figure 36 Test Site and Test Course](image)

![Figure 37 Snapshot of test course contents](image)
7.3 Study Group

Once the evaluation methodology was fixed, it was required to decide upon the specifications of the study group and recruiting participants for the usability study based on them.

7.3.1 Number of users for evaluating

The first and obvious question was ‘how many users needed to be evaluated?’. According to Nielson, the answer to that, is five. He states that after testing with five users, one almost always gets close to the user testing’s maximum benefit-cost ratio. His studies reveal, 85% of the usability problems of a design are discovered after evaluating with the first five users. However, when a product caters to highly distinct groups of users, it is required to test with people from both groups. Therefore, in testing multiple groups of disparate users, Nielson recommends,

- 3-4 users from each category if testing two groups of users
- 3 users from each category if testing three or more groups of users

Since the ‘Learning Strategizer’ has two distinct modules—teacher and student, following Nielson’s recommendation, it was required to evaluate users from both modules [68].

7.3.2 User attributes

For the teacher module, the participants of the study had to fulfill the below characteristics as good as possible:

- Experience in teaching
- Experience with learning management system (preferably Moodle) as a teacher
- Good knowledge of Self-Regulated Learning and learning paths
For student module, the participants of the study should be active students fulfilling the below requirements as good as possible:

- Current level of education
- Experience with Moodle as a student
- Knowledge about Self-Regulated Learning and Learning Paths

The teaching experience requirement for the teacher profile can be used as a predictive measure of the individual’s ability to work with and impart knowledge to students. Similarly, for the student profile the level of education, denoted by current semester the student is in and the degree they are pursuing, can give an insight into how experienced they are with respect to take in learning and learning practises. Experience with learning management system was required, in case of the teacher module, to know if the user is acquainted with setting up a course with resources, quizzes, assignments, etc and for the student module, to know if they are familiar with the platform settings of reading the uploaded learning materials, participating in quizzes, submitting assignments etc. If the participant is familiar with Moodle, then this gets even better since there will be no need to understand the platform system and its associated know-hows. Knowledge about Self-Regulated Learning and knowledge paths will enable the participants to understand how this plugin functions and qualify them to provide a useful feedback regarding the effectiveness of the plugin at the end of the study.

For the evaluation an 8-paged handout for the teachers and a 7-paged handout for the students were prepared [Appendix A Evaluation Handout]. The first page provided them with a brief overview of the origin, description and functionalities of the Learning Strategizer. The information regarding their existing experience was recorded with the following questions:

For teacher module participants,
- Describe your experience in: In Teaching (in semesters)
- Describe your experience in: In using learning management systems as a teacher (in semesters)
- Describe your experience in: In teaching with Moodle (in semesters)

For student module participants,
- State the semester you are currently in
- Which level of education are you currently studying
- Describe your experience in: in studying with Moodle (in semesters)

The common questions for participants of both modules are as follows:
- Knowledge about Self-Regulated Learning
- Knowledge about Learning Paths

### 7.3.3 Task Lists

Next was deciding on the list of tasks for participants of both modules. Both sets of participants needed to execute the tasks in a goal driven manner. Hence the task list of the Teacher Module was decided as follows:

- **Task 1 (TT1):** Create and publish a learning path
- **Task 2 (TT2):** Edit / delete a ‘non-published’ learning path. This was marked as an ‘optional’ task, the evaluators may or may not choose to do it, since this was more of an additional feature to rectify mistakes and not one of the principal functions
- **Task 3 (TT3):** Approve or reject a learning path created and submitted by students
- **Task 4 (TT4):** Review Visual Statistics
• **Task 5 (TT5):** Setting additional rules for students who wish to create their own learning paths. This task was also marked ‘optional’ since this not part of the principle functions of the plugin.

The task list for the participants of the Student Module is as follows:

• **Task 1 (ST1):** Select a learning path from already existing learning paths
• **Task 2 (ST2):** Complete the requirements according to a learning path and choose a learning path for the next section. The process is more or less the same, hence this is marked optional. This was included to check if the students can understand the transition.
• **Task 3 (ST3):** Make your own learning path
• **Task 4 (ST4):** Review Visual Statistics

At the end of the tasks, the participants are provided with an additional section, called ‘Overall Experience’ where they are required to provide their comprehensive opinion and feedback about the plugin as a whole. These include design related feedback and whether they think this is a useful tool with respect to strategizing studies.

7.3.4 Recruiting Participants

An email-based invite, with brief overview of the project, was sent out to both teachers and fellow students whose contacts remained based on previous working relationships or collaborations. From respondents, five teachers and five students were chosen based on experience in teaching, Moodle, SRL, learning path knowledge and low geographical distance. Though Nielson recommended 3-4 users, five users were evaluated since they were all within the university campus and hence fell within the effort bandwidth of the evaluation study. Each of them was given a copy of the Evaluation Handout Appendix A Evaluation Handout) which explained the origins of the plugin and listed the Tasks discussed previously with provisions for the user to write their responses.

7.4 Evaluation Study Observations

7.4.1 Teacher Evaluation

For the teacher evaluation, there were 5 teachers who will be denoted by Teacher1, Teacher2, Teacher3, Teacher4, Teacher5. The teachers had five tasks as mentioned in 7.3.3, the results of which will be discussed in this section. Regarding the plugin interface’s responsiveness and feedback, rating range from ‘Strongly Agree’ is denoted with 5 and ‘Strongly Disagree’ with 1. Regarding experience of using the plugin for a task, the rating ranges from ‘Excellent Experience’ denoted with 1 and ‘Poor Experience’ with 5.

<table>
<thead>
<tr>
<th>RATING TOPIC</th>
<th>BEST</th>
<th>WORST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plugin interface’s responsiveness and feedback</td>
<td>5 – Strongly Agree</td>
<td>1-Strongly Disagree</td>
</tr>
<tr>
<td>Experience of using the plugin for a task</td>
<td>1 – Excellent Experience</td>
<td>5 – Poor Experience</td>
</tr>
</tbody>
</table>

Table 6 Rating Reference

*Overview of TT1:* For TT1, all teachers were able to create and publish learning paths. Some had problems to understand ‘create’ and ‘define indicated the same thing, since the task list asked them to ‘create’ a learning path and the interface displayed ‘define a learning path’. Another prominent problem, the teachers faced, was to understand which tab of the ‘Add Learning Path’ operation they were currently on. Following the scale defined in Table 6 the ratings regarding the plugin interface’s responsiveness and feedback has been illustrated in Table 7 and scoring of the plugin based on TT1 is shown in Figure 39

Amrita Deb - Use of Gamification as a support for strategizing in Self-Regulated Learning
Amrita Deb - Use of Gamification as a support for strategizing in Self-Regulated Learning

<table>
<thead>
<tr>
<th>The interface was easy to understand</th>
<th>The interface was consistent throughout the application</th>
<th>The plugin was responsive</th>
<th>The plugin provided timely feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher1</td>
<td>5</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Teacher2</td>
<td>5</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Teacher3</td>
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<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Teacher4</td>
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<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Teacher5</td>
<td>4</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td><strong>AVERAGE</strong></td>
<td><strong>4</strong></td>
<td><strong>4.6</strong></td>
<td><strong>4.4</strong></td>
</tr>
</tbody>
</table>

Table 7 Interface, responsiveness feedback rating of plugin by teachers based on TT1

**Overview of TT2:** For TT2, all teachers were able to delete a ‘non-published’ learning path. Some didn’t like the concept that they couldn’t delete or edit a published path and that made publishing risky for them. Many also didn’t like that even after deleting and getting a confirmation message the page still showed the already deleted path when they expected it to be removed from the list.

<table>
<thead>
<tr>
<th>The interface was easy to understand</th>
<th>The interface was consistent throughout the application</th>
<th>The plugin was responsive</th>
<th>The plugin provided timely feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher1</td>
<td>5</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Teacher2</td>
<td>5</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Teacher3</td>
<td>5</td>
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<td>5</td>
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<tr>
<td>Teacher4</td>
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<td>4</td>
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<tr>
<td>Teacher5</td>
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<td>5</td>
<td>4</td>
</tr>
<tr>
<td><strong>AVERAGE</strong></td>
<td><strong>4.8</strong></td>
<td><strong>4.8</strong></td>
<td><strong>4.2</strong></td>
</tr>
</tbody>
</table>

Table 8 Interface, responsiveness feedback rating of plugin by teachers based on TT2
Overview of TT3: For TT3, most teachers could approve and reject the dummy paths provided to them. However, the same issue of the form reappearing with their entered value was not a very likeable feature. Teacher 4 suggested he would have liked it better if each learning path had their own approve and reject buttons instead of the checkbox concept.

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Interface easy to understand</th>
<th>Interface consistent throughout the application</th>
<th>Plugin was responsive</th>
<th>Plugin provided timely feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher1</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>5</td>
</tr>
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<td>Teacher2</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Teacher3</td>
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<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Teacher4</td>
<td>4</td>
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<td>4</td>
</tr>
<tr>
<td>Teacher5</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 9 Interface, responsiveness feedback rating of plugin by teachers based on TT3

Figure 40 Rating of plugin by teachers based on TT2

Figure 41 Rating of plugin by teachers based on TT3
Overview of TT4: For TT4, the teachers really liked the graphs and the information it provided. But they were unified in their dislike of the visual statistics being divided into two pages. They spent a considerable amount of time searching for the 2 graphs that were on the second page and probably wouldn’t have found it if the task sheet didn’t mention them. However, all of them found it eventually but remarked they would have liked it if all graphs were together in one page.

<table>
<thead>
<tr>
<th>Teacher</th>
<th>The interface was easy to understand</th>
<th>The interface was consistent throughout the application</th>
<th>The plugin was responsive</th>
<th>The plugin provided timely feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher1</td>
<td>5</td>
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<td>2</td>
<td>3</td>
</tr>
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<td>Teacher2</td>
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</tr>
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<td>Teacher3</td>
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<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Teacher4</td>
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<td>4</td>
</tr>
<tr>
<td>Teacher5</td>
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<td>5</td>
<td>5</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>4.4</td>
<td>4.6</td>
<td>4</td>
<td>4.4</td>
</tr>
</tbody>
</table>

Table 10 Interface, responsiveness feedback rating of plugin by teachers based on TT4

![Rating of plugin based on TT4](image)

Overview of TT5: Teachers struggled to understand the concept of ‘Set Rules’ in TT5. In addition, they didn’t like the concept that they couldn’t add a constraint involving more than one type of module. Teacher 4 further commented that he would have preferred if the ‘Set Rules’ was a separate option altogether instead of being clubbed together with the various tabs of publish, edit, delete and define learning paths.

<table>
<thead>
<tr>
<th>Teacher</th>
<th>The interface was easy to understand</th>
<th>The interface was consistent throughout the application</th>
<th>The plugin was responsive</th>
<th>The plugin provided timely feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher1</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Teacher2</td>
<td>3</td>
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<td>Teacher3</td>
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<td>5</td>
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</tr>
<tr>
<td>Teacher4</td>
<td>2</td>
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<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Teacher5</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
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<td>3.4</td>
<td>4.6</td>
<td>4</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Table 11 Interface, responsiveness feedback rating of plugin by teachers based on TT5
7.4.2 Student Evaluation

For the student evaluation, there were 5 students who will be denoted by Student 1, Student 2, Student 3, Student 4 and Student 5. The students had four tasks and followed the same rating system as the teachers.

Overview of ST1: For ST1, all students could successfully select a learning path and understand its requirements. They all agreed that interface was sufficiently easy to understand and consistent throughout the task. The students also scored the plugin high in terms of responsiveness and timely feedback. Following the rating scale defined in Table 6 the scores given by the students are denoted in Table 12 and graphically represented in Figure 44. The students appreciated the feedback provided with major actions which made the interface intuitive. However, Student 4 suggested it would have been better if there were more hints and the progress timeline to be strictly from top to bottom and not side by side. Student 5 didn’t like that after choosing a path she was still in the plugin page. She preferred if she could go to the main course page instead.

<table>
<thead>
<tr>
<th>The interface was easy to understand</th>
<th>The interface was consistent throughout the application</th>
<th>The plugin was responsive</th>
<th>The plugin provided timely feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student 1</td>
<td>4</td>
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</tr>
<tr>
<td>Student 2</td>
<td>4</td>
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</tr>
<tr>
<td>Student 3</td>
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<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Student 4</td>
<td>4</td>
<td>4</td>
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</tr>
<tr>
<td>Student 5</td>
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</tr>
<tr>
<td>AVERAGE</td>
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<td>4</td>
<td>4.6</td>
</tr>
</tbody>
</table>

Table 12 Interface, responsiveness feedback rating of plugin by students based on ST1
Overview of ST2: For ST2, all students could successfully complete requirements of a section according to their respective learning path but for being able to select a learning path for the next section, everyone except Student 1, succeeded. Student 1 wasn’t able to select learning path for the next section because he thought only doing the ‘Required’ modules would be enough, so he finished them but left out the modules that were marked ‘Include’. Hence the plugin prohibited him from making paths for the next section. He argued that if he had to finish everything either way, why were they marked differently. Student 3 and 4 also had the similar confusion and suggested that either they shouldn’t be marked differently to begin with or there should be hints at some point that they need to finish ‘Include’ marked modules as well to progress. Student 2 stated that something should be done to make the requirements of the learning path they are following to always be visible. He would be too lazy to check the requirements again and again. Student 5 suggested that the progress view should be the main view of the plugin and that there should also be a link from the progress view to the page of choosing learning paths. Consequently, there were mixed reviews about the interface and responsiveness of the plugin for this task. The scores and bar graph are denoted in Table 13 and Figure 45.

<table>
<thead>
<tr>
<th>The interface was easy to understand</th>
<th>The interface was consistent throughout the application</th>
<th>The plugin was responsive</th>
<th>The plugin provided timely feedback</th>
</tr>
</thead>
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<tr>
<td>Student 1</td>
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<tr>
<td>Student 4</td>
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<tr>
<td>Student 5</td>
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<td>4</td>
<td>5</td>
</tr>
<tr>
<td><strong>AVERAGE</strong></td>
<td><strong>3.6</strong></td>
<td><strong>4.4</strong></td>
<td><strong>4</strong></td>
</tr>
</tbody>
</table>

Table 13 Interface, responsiveness feedback rating of plugin by students based on ST2
Overall of ST3: For ST3, some students didn’t like that they had to wait for the teacher’s approval of path to progress within the plugin. Student 2 remarked that if he knew he had to wait for approval, he would have not chosen to create his own. The students felt that there should be more prominent hints displayed regarding this approval flow and preferred if there was an option to undo their choice. The scoring of the plugin based on this task are given in Table 14 and Figure 46.

<table>
<thead>
<tr>
<th>The interface was easy to understand</th>
<th>The interface was consistent throughout the application</th>
<th>The plugin was responsive</th>
<th>The plugin provided timely feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student1</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Student2</td>
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<td>Student3</td>
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<td>Student4</td>
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<td>Student5</td>
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</tr>
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<td>AVERAGE</td>
<td><strong>3.6</strong></td>
<td><strong>4.4</strong></td>
<td><strong>4.4</strong></td>
</tr>
</tbody>
</table>

Table 14 Interface, responsiveness feedback rating of plugin by students based on ST3

Figure 45 Rating of plugin by students based on ST2

Figure 46 Rating of plugin by students based on ST3
Overview of ST4: For ST4, all students liked the visualizations and the hovering effect which gives more details. Like the teachers, they also had much difficulty since the graphs were divided into two pages. Due to this, participating students couldn’t find one graph or the other.

<table>
<thead>
<tr>
<th></th>
<th>The interface was easy to understand</th>
<th>The interface was consistent throughout the application</th>
<th>The plugin was responsive</th>
<th>The plugin provided timely feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student1</td>
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<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Student2</td>
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<td>4</td>
<td>2</td>
</tr>
<tr>
<td><strong>AVERAGE</strong></td>
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<td><strong>3.6</strong></td>
<td><strong>4.6</strong></td>
<td><strong>4</strong></td>
</tr>
</tbody>
</table>

Table 15 Interface, responsiveness feedback rating of plugin by students based on ST4

![Rating of plugin based on ST4](image)

Figure 47 Rating of plugin by students based on ST4

7.4.3 Overall View of both User Groups

**Teachers:** All the teachers agree that ‘Learning Strategizer’ tool will help students to self-regulate themselves. The tool also provides students, who don’t practise SRL, with pre-defined paths, so that they are not completely lost. The gamification aspect makes it interesting, encouraging students to use it more.

**Students:** Most of the students agreed that ‘Learning Strategizer’ is a useful tool and can help them monitor their progress through a course. However, there were some downsides too. Few of them didn’t like the fact that they had to wait for teacher’s approval for their self-created learning path and believed it hindered in their autonomy of the learning process. In addition, the tool enforces students to proceed chronologically however, in reality, students don’t always study in a defined direction.
Figure 48 and Figure 49 demonstrate teachers’ and students’ ratings, respectively, of the plugin based on two criteria,

- As a teacher/student, the tool will be helpful in learning: The rating ranges from ‘Strongly Agree’, denoted with 5 and ‘Strongly Disagree’ with 1
- Rating of the plugin as a support tool for self-regulated learners: The rating ranges from ‘Very Helpful’ denoted with 1 and ‘Not Helpful’ with 5
Chapter 8  Conclusion

This thesis attempted to provide a gamified tool to support self-regulated learners in the forethought phase of their learning through the Moodle block plugin Learning Strategizer. The plugin aims to accomplish this through learning paths. Learning Strategizer prompts students to follow a learning path for each section of a course. The students are free to either choose a learning path from a set of paths designed by the teachers or create their own following rules specified by the teacher. In case of latter their paths are submitted to the teachers for approval to ensure the path’s integrity. A usability study was conducted post development, with 5 teachers and 5 students to evaluate the plugin. Based on the results of the evaluation study, it can be concluded that the Learning Strategizer accomplished to fulfil its goal, since majority of both sets of users—teachers and students—agreed that the tool, will aid learners to self-regulate and monitor themselves in the duration of a course.

Future Work

Based on the evaluations study results and observations, there are several things that can be improved and considered as future work of the plugin. This section lists them and discusses them briefly.

The teachers had to constantly check, manually, for pending path requests. Similarly, students also had to constantly check the status of their path requests manually. Providing a notification module for such events as well as others like, publication of a new path, progress update; can be a useful feature. Additionally, prompts in the Learning Strategizer is currently limited to mere text. This can be enhanced with interactive message boxes. This can be, especially useful in case of significant operations like publishing and deleting paths to ensure that the teacher knows what they intend to do and its consequences.

One improvement can be a feature to import and export learning paths. In most academic institutions, a course offering is repeated after some semester intervals. In such cases, instead of asking the teachers to build a path every time, it will increase the reusability of the plugin if there was an option to export popular learning paths and import them when the course is offered again. Bulk upload is a very convenient option provided in Moodle. Similar to bulk enrolment and bulk grade upload features, it would be convenient if the teachers could bulk upload learning paths in. This way, they don’t have to define learning path repeatedly and be mindful about keeping the required modules constant.

Another improvement can be machine learning driven suggestion provider, which learns from learners’ chosen paths and recommends paths or resources that will benefit them for the next section. Moodle provides time logs for events as well. Introducing new statistics based on those time logs can benefit students to monitor themselves and provide insight to teachers like which resource students are spending most time on or how many attempts students require to finish a quiz etc.

It is beneficial for teachers to understand what kind of learner their students are. Based on that, they can modify their course materials and provide better resources. The learning paths chosen by a student through the ‘Learning Strategizer’ for the duration of a course provides an intuition on the kind of learning the student prefers. The data from the chosen learning paths may be useful to pinpoint the type of learner a student is.
Appendix A Evaluation Handout

**LEARNING STRATEGIZER EVALUATION SHEET (TEACHER)**

At the core of my thesis lies the concept of Self Regulated Learning (SRL). Barry Zimmerman’s SRL model is a cyclic process consisting of three phases—Forethought Phase, Performance Phase and Self-Reflection Phase.

**Cyclic Process of Self-Regulated Learning**

Inclusion of gamification into the various phases of self-regulated learning has proved to be exceptionally motivating due to its small feedback cycles and engaging content. Online learning platforms have adapted various gamified elements that support and better the monitoring, reinforcement stages of SRL. However, there is a lack of gamified tools or elements to enhance the goal setting stage of the SRL process. Understanding this gap and with the intention to introduce an element for the Forethought Phase, we developed Learning Strategizer.

<table>
<thead>
<tr>
<th>FORETHOUGHT PHASE</th>
<th>PERFORMANCE PHASE</th>
<th>SELF-REFLECTION PHASE</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Forethought Icon" /></td>
<td><img src="image2.png" alt="Performance Icons" /></td>
<td><img src="image3.png" alt="Self-Reflection Icons" /></td>
</tr>
</tbody>
</table>

Learning Strategizer is a block type Moodle Plugin which will help students plan their studies within a course or build their Learning Path within the course. (A Learning Path is a selection of materials/resources tied together for learners to progress through, mastering a particular subject or program). They can choose their learning path from pre-defined Learning Paths designed by teachers or design their own.

As a teacher, with this tool, you can:
1. Define Learning Path which becomes pre-defined Learning Paths that students can choose to follow.
2. Set extra rules or constraints that students making custom Learning Paths must follow.
3. Edit the Learning Plans you created in (1.) before Publishing.
4. Delete any of the Learning Paths you created in (1.), provided they are not published.
5. Publish your Learning Path so that it is available to students. A published Learning Path will no longer be available for deletion or edit.
6. Approve a Learning Path submitted by a student.
7. Reject a Learning Path submitted by a student citing reason.
Amrita Deb - Use of Gamification as a support for strategizing in Self-Regulated Learning

PERSONAL INFORMATION:
Name: ____________________________________________________________

Describe your experience in Teaching (in years):
0 1-2 3-5 6-10 More than 10

Describe your experience in: In gamifying learning management systems as a teacher (in semesters)
0 1-2 3-5 6-10 More than 10

Describe your experience in: In teaching with Moodle (in semesters)
0 1-2 3-5 6-10 More than 10

Knowledge about Self-Regulated Learning
Never heard of it Hand on it Worked with Good knowledge Very good knowledge

Knowledge about Learning Paths

TASK LIST:

Presented to you is a sample course ‘How to make Pasta’. The course is used as an test environment for the evaluation.

Task 1: Create and Publish a Learning Path
Please indicate your answers based on your experience on the above task:

Did you successfully create Learning Paths using the plugin? YES  NO  NA

Did you successfully publish Learning Paths using the plugin? YES  NO  NA

The interface was easy to understand:
Strongly Agree  Agree  Neutral/Neither agree or disagree  Disagree  Strongly Disagree

The interface was consistent throughout the application:
Strongly Agree  Agree  Neutral/Neither agree or disagree  Disagree  Strongly Disagree

The plugin was responsive:
Strongly Agree  Agree  Neutral/Neither agree or disagree  Disagree  Strongly Disagree

The plugin provided timely feedback:
Strongly Agree  Agree  Neutral/Neither agree or disagree  Disagree  Strongly Disagree

Approximately how many times did you receive error messages like ‘Your action was not successful’? 1-2 times 3-5 times 6-10 times More than 10 times

How would you rate your overall experience to do the task using the plugin from 1 to 5?
1 = meaning you had an excellent experience 5 = meaning you had a poor experience

Comment what you liked about the plugin while performing the task.

Comment what you did not like about the plugin while performing the task.

Task 2: Edit/Modify/Select/Deselect a pre-existing Learning Path
Please indicate your answers based on your experience on the above task:

Did you successfully edit Learning Paths using the plugin? YES  NO  NA

Did you successfully delete Learning Paths using the plugin? YES  NO  NA

The interface was easy to understand:
Strongly Agree  Agree  Neutral/Neither agree or disagree  Disagree  Strongly Disagree

The interface was consistent throughout the application:
Strongly Agree  Agree  Neutral/Neither agree or disagree  Disagree  Strongly Disagree

The plugin was responsive:
Strongly Agree  Agree  Neutral/Neither agree or disagree  Disagree  Strongly Disagree

The plugin provided timely feedback:
Strongly Agree  Agree  Neutral/Neither agree or disagree  Disagree  Strongly Disagree

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How would you rate your overall experience to do the task using the plugin from 1 to 5?
1 = meaning you had an excellent experience 5 = meaning you had a poor experience

Comment what you liked about the plugin while performing the task.

Comment what you did not like about the plugin while performing the task.

Task 3: Approve or Reject a custom Learning Paths submitted by students.

Students submit custom Learning Paths for a course when they don’t wish to follow any of the pre-defined Learning Paths from the teachers. We have created 2 dummy custom Learning Paths and passed it to the Approve queue for the testing of this task.

Did you successfully Approve a custom Learning Paths using the plugin? YES  NO  NA

Did you successfully reject custom Learning Paths using the plugin? YES  NO  NA

The interface was easy to understand:
Strongly Agree  Agree  Neutral/Neither agree or disagree  Disagree  Strongly Disagree

The interface was consistent throughout the application:
Strongly Agree  Agree  Neutral/Neither agree or disagree  Disagree  Strongly Disagree

The plugin was responsive:
Strongly Agree  Agree  Neutral/Neither agree or disagree  Disagree  Strongly Disagree

The plugin provided timely feedback:
Strongly Agree  Agree  Neutral/Neither agree or disagree  Disagree  Strongly Disagree

Approximately how many times did you receive error messages like ‘Your action was not successful’? 1-2 times 3-5 times 6-10 times More than 10 times

How would you rate your overall experience to do the task using the plugin from 1 to 5?
1 = meaning you had an excellent experience 5 = meaning you had a poor experience

Comment what you liked about the plugin while performing the task.

Comment what you did not like about the plugin while performing the task.
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Amrita Deb - Use of Gamification as a support for strategizing in Self-Regulated Learning

LEARNING STRATEGIZER EVALUATION SHEET (STUDENT)

At the core of my thesis lies the concept of Self Regulated Learning (SRL). Barry Zimmerman’s SRL model is a cyclic process consisting of three phases: Forethought Phase, Performance Phase and Self-Reflection Phase.

Cyclic Process of Self-Regulated Learning

Inclusion of gamification into the various phases of self regulated learning has proved to be exceptionally motivating due to small feedback cycles and engaging content. Online Learning platforms have adapted various gamified elements that support and better the monitoring, reinforcement staged of SRL. However, there is a lack of gamified tools or elements to enhance the goal setting stage of the SRL process. Understanding this gap and with the intention to introduce an element for the Forethought Phase we developed Learning Strategizer.

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<th>PERFORMANCE PHASE</th>
<th>SELF-REFLECTION PHASE</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Forethought Phase" /></td>
<td><img src="image2" alt="Performance Phase" /></td>
<td><img src="image3" alt="Self-Reflection Phase" /></td>
</tr>
</tbody>
</table>

Learning Strategizer is a block type Moodle Plugin which will help students plan their studies within a course or build their Learning Path within the course (A Learning Path is a selection of materials/resources tied together for learners to progress through, mastering a particular subject or program). They can choose their learning path from pre-defined Learning Paths designed by teachers or design their own.

As a student, with this tool you can
1. Select a Learning Path from a list of carefully tailored pre-defined Learning Paths created by teachers
2. Change or stay on a Learning Path for a followup section based on your self-reflection phase analysis
3. Create your own Learning Path in case you don’t like any of the pre-defined paths from the teacher
4. View popular Learning Paths and resources that your fellow coursemates are following and completing
PERSONAL INFORMATION:

Name: ________________________________

State the semester you are currently in

<table>
<thead>
<tr>
<th></th>
<th>0-1</th>
<th>2-4</th>
<th>5-7</th>
<th>8-10</th>
<th>More than 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor</td>
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<tr>
<td>Ausbildung</td>
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<td>Diploma</td>
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<tr>
<td>Masters</td>
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<td>PhD</td>
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</table>

Which level of education are you currently studying??

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<tr>
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<th>0-1</th>
<th>2-4</th>
<th>5-7</th>
<th>8-10</th>
<th>More than 10</th>
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</thead>
<tbody>
<tr>
<td>Never heard of it</td>
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<tr>
<td>Heard of it</td>
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<tr>
<td>Worked with it</td>
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<tr>
<td>Good knowledge</td>
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<td></td>
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<tr>
<td>Very good knowledge</td>
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</tbody>
</table>

Knowledge about Self Regulated Learning

<table>
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<tr>
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<th>0-1</th>
<th>2-4</th>
<th>5-7</th>
<th>8-10</th>
<th>More than 10</th>
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<tr>
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</tbody>
</table>

Knowledge about Learning Paths

<table>
<thead>
<tr>
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<th>0-1</th>
<th>2-4</th>
<th>5-7</th>
<th>8-10</th>
<th>More than 10</th>
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<tr>
<td>Very good knowledge</td>
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</tr>
</tbody>
</table>

TASK LIST:

Presented to you is a small sample of ‘How to make Pasta’. The course is used as an test environment for the pilot study.

![Image of pasta making]

To evaluate the Moodle Plus Learning Trajectory, please perform the below tasks. Tasks marked “Optional” you can choose to do them or not.

Task 1: Select a Learning Path from already existing Learning Pats

Please indicate your answers based on your experience on the above task:

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Could you successfully select a Learning Path using the plugin?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongly Agree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Neutral/Neither agree or disagree</td>
<td></td>
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<td></td>
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<tr>
<td>Disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Approximately how many times did you receive error messages? (Select all that apply)

- Cannot redirect to the saved location
- Incorrect input
- Other error messages

<table>
<thead>
<tr>
<th></th>
<th>0 times</th>
<th>1-2 times</th>
<th>3-4 times</th>
<th>5-6 times</th>
<th>More than 6 times</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td></td>
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</tr>
<tr>
<td>Neutral/Neither agree or disagree</td>
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<tr>
<td>Disagree</td>
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<td></td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td></td>
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</tbody>
</table>

How would you rate your overall experience to do the task using the plugin from 1 to 5?

1 – meaning you had an excellent experience
5 – meaning you had a poor experience

<table>
<thead>
<tr>
<th></th>
<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td></td>
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<tr>
<td>Agree</td>
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<td>Disagree</td>
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<tr>
<td>Strongly Disagree</td>
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</tr>
</tbody>
</table>

Comment what you liked about the Plugin while performing the task

Comment what you did not like about the Plugin while performing the task

Task 2: (Optional) Complate the requirements according to Learning Path and choose a Learning Path for the next section

Please indicate your answers based on your experience on the above task:

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Could you successfully complete the requirements of the Learning Path you selected?</td>
<td></td>
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</tr>
<tr>
<td>Strongly Agree</td>
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<tr>
<td>Agree</td>
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<tr>
<td>Neutral/Neither agree or disagree</td>
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<tr>
<td>Disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td></td>
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How would you rate your overall experience to do the task using the plugin from 1 to 5?

1 – meaning you had an excellent experience
5 – meaning you had a poor experience

<table>
<thead>
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<tbody>
<tr>
<td>Strongly Agree</td>
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<tr>
<td>Strongly Disagree</td>
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</tbody>
</table>

Comment what you liked about the Plugin while performing the task

Comment what you did not like about the Plugin while performing the task

Task 3: Make your own Learning Path for a section

In case students don’t like any of the learning Paths provided by the teacher they can create their own with this plugin. Please indicate your answers based on your experience on the above task:

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Could you successfully create your Learning Path using the plugin?</td>
<td></td>
<td></td>
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<tr>
<td>Strongly Agree</td>
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<td>Agree</td>
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How would you rate your overall experience to do the task using the plugin from 1 to 5?

1 – meaning you had an excellent experience
5 – meaning you had a poor experience

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<tbody>
<tr>
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</tr>
<tr>
<td>Strongly Disagree</td>
<td></td>
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</tr>
</tbody>
</table>

Comment what you liked about the Plugin while performing the task

Comment what you did not like about the Plugin while performing the task

Amrita Deb - Use of Gamification as a support for strategizing in Self-Regulated Learning
Amrita Deb - Use of Gamification as a support for strategizing in Self-Regulated Learning

Task 4: Review Visual Statistics
In the ‘View Grade’ page of the plugin, graphs and charts are provided about the below data to provide useful insight to students:

- Could you identify and understand the charts associated with ‘Popular Non-Required Resources across learning paths’? YES | NO
- Could you identify and understand the charts associated with ‘Required Resources and the number of students completing them’? YES | NO
- Could you identify and understand the charts associated with ‘Non-Required Resources and the number of students completing them’? YES | NO
- Could you identify and understand the charts associated with ‘Popular Learning Paths among students’? YES | NO

The interface was:
- easy to understand
- consistent throughout the application
- responsive
- provided timely feedback

Approximately how many times did you receive error messages while using the application?
- 0 times
- 1-3 times
- 4-6 times
- 7-9 times
- 10 times or more

How would you rate your overall experience using the plugin on a scale of 1 to 5?
- 1 - means you had an excellent experience
- 2 - means you had a good experience
- 3 - means you had a fair experience
- 4 - means you had a poor experience
- 5 - means you had a bad experience

Comment what you liked about the plugin while performing the task:

Comment what you did not like about the plugin while performing the task:

Task 5: Overall Experience
Please rate your overall experience and view regarding the plugin:

- Were you satisfied with your experience while working on the above tasks? Extremely Satisfied | Very Satisfied | Somewhat Satisfied | Not at all Satisfied
- The various prompts provided by the plugin were useful enough to execute the tasks and understand the outcome Strongly Agree | Agree | Neutral/Neither agree or disagree | Disagree | Strongly Disagree
- As a student, I think this tool will be helpful for students to plan/strategize their studies Strongly Agree | Agree | Neutral/Neither agree or disagree | Disagree | Strongly Disagree
- This tool provides useful insight to students to understand what level of learning their fellow classmates prefer Strongly Agree | Agree | Neutral/Neither agree or disagree | Disagree | Strongly Disagree
- How would you rate this plugin as a support tool to assist students practicing self-regulated learning to plan their studies 1 | 2 | 3 | 4 | 5
- 1 - Very helpful
- 2 - Moderately helpful
- 3 - Somewhat helpful
- 4 - Not helpful
- 5 - Not at all helpful

Please describe your views about the plugin. Do you think this will be a useful tool for students practicing Self-Regulated Learning to plan their studies?
Appendix B Bibliography


Amrita Deb - Use of Gamification as a support for strategizing in Self-Regulated Learning


[40] D. Pope, Doing school: How we are creating a generation of stressed out, materialistic, and miseducated students, Yale University Press, 2008.


Digital Appendix
Acknowledgement

There are many people who have supported, encouraged and helped me to realise this thesis. I would like to take this opportunity to thank all of them, whose assistance was a milestone in the completion of this project.

First, I would like to thank Prof. Dr. Ulrike Schroeder for encouraging me to write this thesis in the interesting field of eLearning. I am also thankful to Prof. Dr. Matthias Jarke for co-examining this thesis. Next, I wish to express my sincerest gratitude to my supervisor, Nadja Zaric. She has supported me since the genesis of the thesis and her advice, recommendation and comments were invaluable in the development of this project. Without her persistent help, the goal of this project would not have been realised. I wish to acknowledge the support of Svenja Noichl and Angelika Bombelka, who assisted me with the various administrative processes regarding the thesis.

I would like to thank all the teachers and students who participated in the usability study. Their input has been crucial in the evaluation of the plugin.

Last but not the least, I would like to express my profound gratitude to my parents. Despite being thousands of kilometres away, the moral support and continuous encouragement they provided has been indispensable in not only the period of this thesis but my entire master study.

My accomplishments would not have been possible without the above-mentioned people, playing their respective roles in my life. They all kept me going and this thesis would not have been possible without them.
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