Support for the Orchestration of Agile Teaching-Learning Processes through Learning Analytics and Generative Artificial Intelligence

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Abstract

Traditional education presents various issues that can be addressed by agile education, such as the inefficient review of project plans or delays in project scheduling. However, agile education also presents several challenges, such as finding it difficult to estimate and plan tasks and lecturers experiencing an increased workload in course orchestration. Learning Analytics (LA) and Generative Artificial Intelligence (GenAI) could help lecturers and students with the orchestration of courses. Nevertheless, we identified a lack of studies addressing the orchestration problems faced by lecturers and students in higher education courses implemented with agile methodologies, as well as a lack of support for them. Consequently, this thesis focuses on the problem of how to support lecturers and students with the orchestration challenges they face when implementing agile practices in teaching and learning.

Keywords

Agile education, Lecturers, Orchestration, Learning Analytics (LA), Generative Artificial Intelligence (GenAI)

1. Introduction

In 2001, the Agile Manifesto for Software Development set out the four values and twelve principles that any agile methodology must adhere to. These methodologies are characterized by being customer-oriented, collaborative, iterative, incremental, and adaptable to change [1]. Since then, some well-known methodologies and frameworks have emerged, such as Scrum, Extreme Programming (XP), Crystal, Feature Driven Development (FDD), Kanban, ... [1, 2].

Agile in education is promising because it helps to solve some of the problems posed by traditional approaches [3]. These include improved project planning, a more balanced student workload across courses and semesters, greater efficiency in planning and reviewing documents, and a shift in the role of students away from the more peripheral aspects of course design. It is characterized by active learning and participation, direct and frequent communication with the instructors, not only individual but also collaborative work, short iterative cycles with continuous feedback, and the ability to adapt quickly to change [4]. Some examples are:

- eduScrum is an educational framework based on Scrum in "which students tackle complex adaptive problems, while productively and creatively achieving learning goals and personal growth of the highest possible value" [5].
- eXtreme Learning is an integral framework inspired by the principles of agile methodologies and designed to transform higher-education courses into learning projects implemented incrementally [6].

Nevertheless, agile methodologies present several challenges in education. Students might struggle with teamwork coordination, understanding the methodology, task estimation and planning, and evenly

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distributing their work [7, 8, 9]. This may result in overestimation, effort imbalances and initial stress when faced with a new methodology. Lecturers, conversely, encounter the challenge of an increased workload in course orchestration, especially in monitoring, warning, and tracking student progress [7].

To address these challenges, Learning Analytics (LA) could be of great help for the different stakeholders. LA is defined by Solar as "the collection, analysis, interpretation and communication of data about learners and their learning that provides theoretically relevant and actionable insights to enhance learning and teaching" [10]. Among the different research lines within the field, one deals with the pedagogical grounding of LA and the connection with Learning Design. Instruments such as the Analytics Layers for the Analytics Learning Design (AL4LD) framework help researchers reflect on the relations and interactions between educational data and learning designs, and position themselves in relation to the focus of the analysis [11]. Out of the three AL4LD layers –community analytics, design analytics, and LA–, this thesis addresses the second and third layers. Regarding the Design Analytics layer, we aim to better understand the influence of the design decisions (e.g., types of tasks, load) on the learning process, promoting teacher reflection and redesign. In terms of the Learning Analytics layer, our goal is to extract metrics about the learning process and outcomes while the students experience a learning design, helping teachers and students to monitor, regulate, and evaluate the learning activity.

Furthermore, recent studies show that the use of Generative Artificial Intelligence (GenAI) in course redesign yields better results [12]. Some examples of how GenAI can support the orchestration of a course curriculum include the automatic generation of materials (rubrics, activities, ...), the use of chatbots designed for a specific course with 24/7 support, and the real-time adaptation of course content [13, 12]. Additionally, GenAI can personalise learning pathways by tailoring content and difficulty levels to individual students' need and it can also predict which students are at risk of dropping out or failing a course [12].

However, we have identified three problems: 1) insufficient concept mapping between education and agile methodologies regarding general concepts of agile methodologies in education and educational metrics related to product, process and metrics [14], 2) lack of studies that identify the orchestration problems of lecturers and students in higher education courses implemented with agile methodologies, and 3) lack of support for lecturers and students in higher education courses implemented with agile methodologies [15]. With the aim of addressing these three issues, this thesis poses the following research question: How can we support lecturers and students with the orchestration challenges they face when implementing agile practices in teaching and learning processes?

Figure 1 provides an overview of the thesis, including the context, the research question, the objectives, the expected contributions, and the evaluations. The four goals proposed in this thesis are: (1) to identify the main challenges faced by lecturers and students when orchestrating teaching and learning processes using agile practices, (2) to identify indicators and metrics that allow informing and improving agile teaching and learning practices, (3) to identify the main challenges faced by lecturers and students when orchestrating agile practices, and (4) to design a technological architecture that supports the orchestration of teaching and learning processes based on agile practices by the lecturers (e.g., design, deployment, monitoring, regulation and evaluation) and by the students (e.g., self-regulation throughout the course).

The rest of the paper is structured as follows. Section 2 presents the research methodology. Section 3 introduces the expected contributions. Finally, Section 4 reports the current status and research.

2. Research Methodology

In order to answer the RQ and achieve the three proposed goals of this thesis, an appropriate research methodology had to be selected. Therefore, a design-oriented, interventionist and exploratory approach was chosen. Based on these criteria, two methodological alternatives were initially considered: Design Science Research Methodology (DSRM) and Design-Based Research (DBR). Finally, the DBR methodology was selected because the research aims to design and implement a technological architecture and develop design guidelines.This methodology is characterized by an iterative process, consisting of cycles of

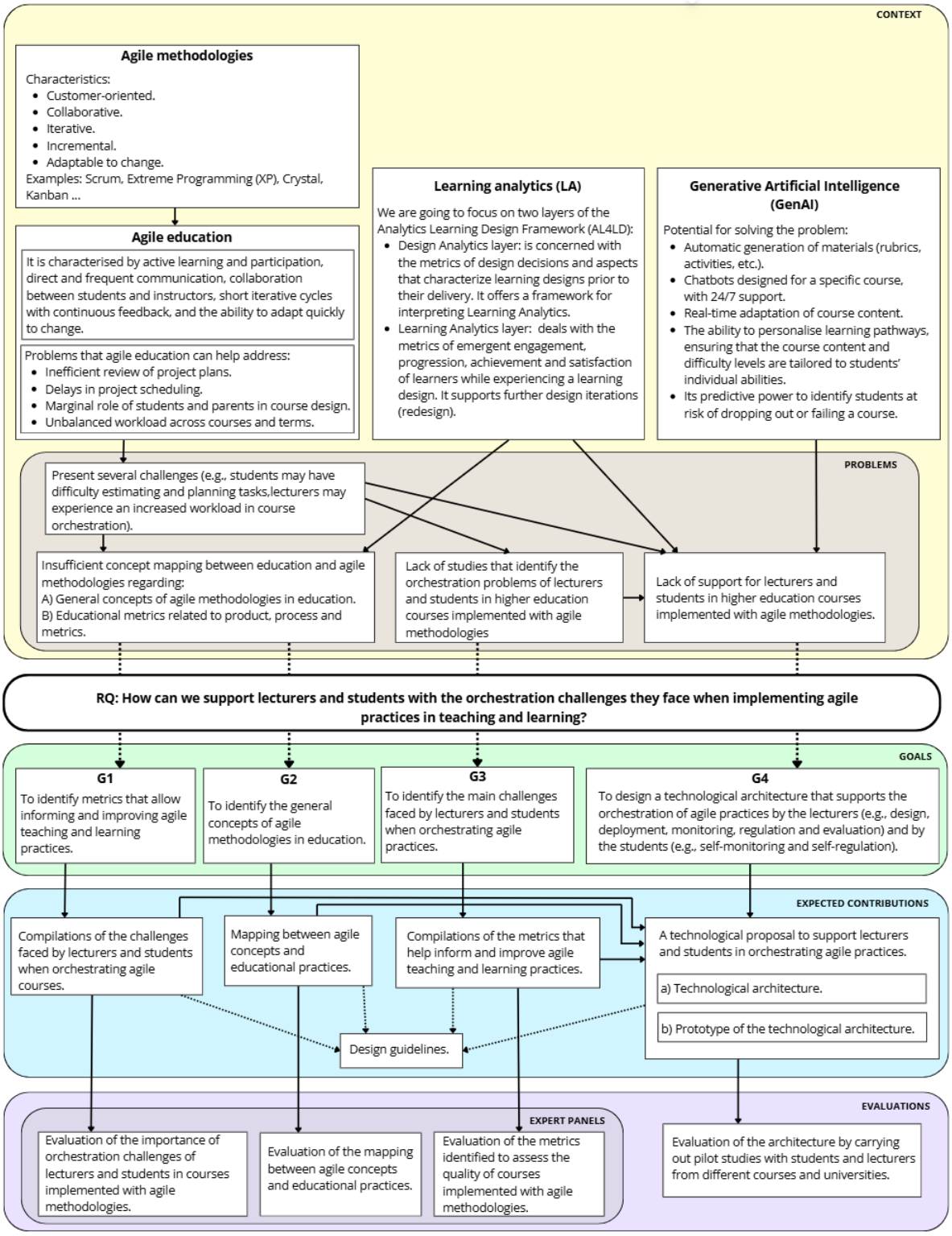

Figure 1: Thesis diagram showing the context, the problems, the goals, the expected contributions and the evaluations.

analysis, design and development and evaluation [16]. Furthermore, it is a methodology that involves constant collaboration among researchers, lecturers, and other actors in the educational context and uses mixed methods, combining multiple techniques (quantitative and qualitative) according to the needs of the research [17].

Figure 2 presents the thesis planning following the DBR methodology. We initially planned three

iterations. In the first iteration, our objective is to develop a first technological proposal to support lecturers and students in orchestrating agile learning practices, based on the main challenges identified in the literature and in a lecture of one case study. To this end, we plan to conduct an analysis related to the objective of identification: (1) the main challenges faced by lecturers and students when orchestrating teaching and learning processes using agile practices, (2) the metrics that inform agile teaching and learning practices, (3) the general concepts of agile methodologies in education and, (4) different higher education courses from distinct universities implemented with agile methodologies. With the main challenges identified, we will develop the first sketch of the technological architecture and the first prototype. Subsequently, we will do four evaluations: (1) this prototype in one case study; (2) the importance of orchestration challenges of lecturers and students in courses implemented with agile methodologies, as discussed by an expert panel; (3) the metrics and indicators identified to assess the quality of courses implemented with agile methodologies, as discussed by an expert panel; and (4) the mapping between agile concepts and educational practices, as discussed by an expert panel. In the second iteration, our objective is to redesign the technological proposal based on the evaluation of the first iteration, new identified challenges and compilations of studies that use GenAI to assist with lecturers' orchestration workload. To this end, we will begin by identifying studies that use generative artificial intelligence to help orchestrate the workload of lecturers and students and to identify other challenges and metrics. Using this information, along with the results of the first prototype evaluation, we will redesign the technology architecture and the prototype. We will conclude this second iteration by evaluating this new prototype with more than one of the previously identified case studies. Finally, in the third iteration, our objective is to develop a final technological proposal to support lecturers and students in orchestrating agile practices, based on the evaluation of the second iteration and compilations of studies that use GenAI to assist with students' orchestration workloads. To this end, we will start identifying studies that use GenAI to help with the orchestration workload for students. Afterward, we will redesign the technological architecture and the prototype taking into account the results obtained from the evaluation carried out in the second iteration and the new studies identified. We will conclude by evaluating the new prototype using more than one case study.

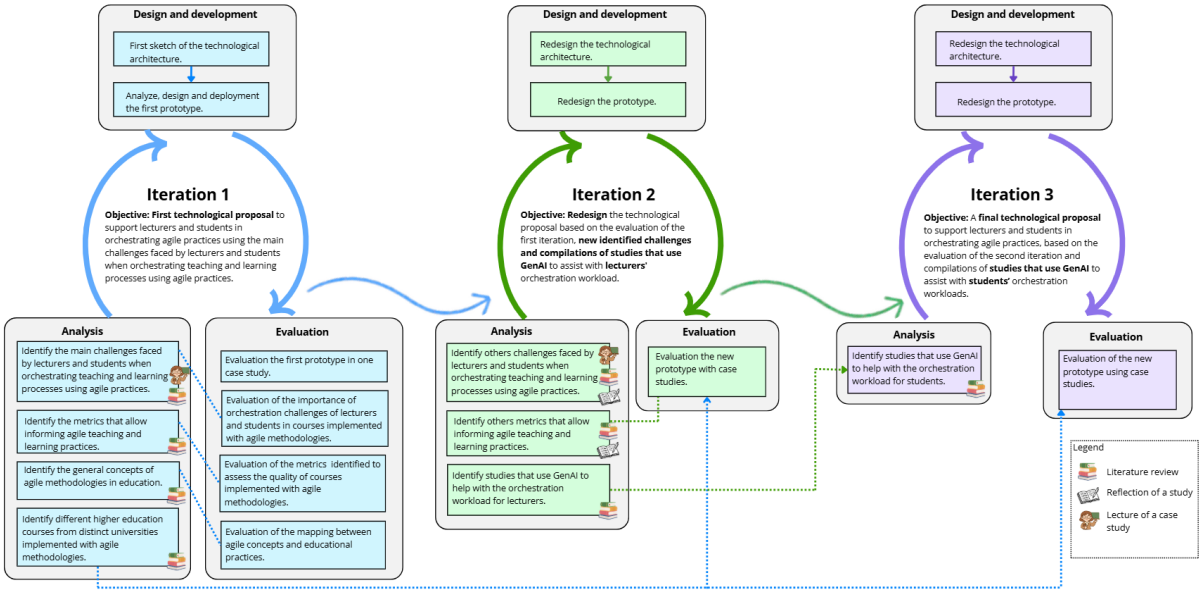

Figure 2: Overview of the Design-Based Research Thesis Methodology.

3. Expected Contributions

This thesis is expected to make four key contributions (Figure 1) with the aim of answering the research question: How can we support lecturers and students with the orchestration challenges they face when implementing agile practices in teaching and learning. These contributions are: 1) compilations of the challenges faced by lecturers and students when orchestrating agile courses, 2) mapping between agile concepts and educational practices, 3) compilations of the indicators and metrics that help inform and improve agile teaching and learning practices and 4) a technological proposal to support lecturers and students in the orchestration of teaching and learning processes based on agile practices, consisting of a technological architecture and a prototype of this technological architecture.

These contributions are novel in the field of using learning analytics and GenAI to support teachers and students in orchestrating agile courses. Unlike project management tools such as Trello, Jira, or GitHub Classroom, which are geared toward technical management and assume software development expertise, the technological architecture proposed in this thesis will be designed for non-expert teachers and will address not only the (re)design of courses but also educational processes such as regulation and self-assessment. Integrating all these dimensions into a learning management system (LMS) is not trivial; therefore, the thesis adopts an exploratory approach to analyze how these components can be meaningfully integrated.

4. Current Status and Research

So far, the author has been working on the first iteration of the thesis plan. She has carried out a preliminary literature review of the main challenges faced by lecturers and students when orchestrating teaching and learning processes using agile practices. Namely, we have found that students often struggle with teamwork, understanding the methodology, planning and estimating tasks, and distributing work evenly [7, 8, 9]. At the same time, lecturers face the challenge of an increased workload in course orchestration, particularly in monitoring, warning, and tracking student progress [7].

She has also made a first sketch of the technological architecture and analyzed, designed, and deployed the first prototype and evaluated it in one case study. In this case study, we aimed at supporting lecturers in redesigning agile courses based on the lessons learnt from the previous year, with the student workload being the main lecturers' concern. Using the A4CD framework by [18], we created a dashboard to inform lecturers about possible overlapping between activities of the same type and about those activities in which the actual workload of the students exceeds the estimated workload. The dashboard used data from the Database Systems course within the Computer Engineering for Services and Applications degree at the University of Valladolid for the 2024-2025 academic year. The tool was evaluated with 3 current lecturers and one former lecturer from the analyzed course. We found out that the tool was easy to use, understandable, usefulness, novelty and triggered lecturers to modify the learning design for the next academic year. The teacher also raised other challenges to be taken into consideration such as the complexity of deploying the learning design in a learning management system and monitoring the learning process to inform teacher interventions (e.g., adapting the learning design or supporting struggling students).

Now she is working on the extraction of: 1) metrics that allow informing agile teaching and learning practices, 2) general concepts of agile methodologies in education and, 3) different higher education courses from distinct universities implemented with agile methodologies, coming from the literature. Next, she will evaluate these challenges, the metrics and concepts identified. The findings from the literature will be expanded and triangulated with those from experts (e.g., by means of panels) and stakeholders (e.g., as part of the case studies).

The following steps that she has planned correspond to Iteration 2, which entail the identification of 1) studies that use GenAI to help with the orchestration workload for lecturers, 2) other challenges faced by lecturers and students when orchestrating teaching and learning processes using agile practices and, 3)other metrics that allow informing agile teaching and learning practices. Later, using this new

information, we will redesign the technological architecture and the prototype, and evaluate them using several case studies.

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Declaration on Generative AI

The authors have not employed any Generative AI tools.

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