Smart Groups: Group orchestration in synchronous hybrid learning environments

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Abstract

This PhD is framed within the fields of the Smart Learning Environment, collaborative learning and the impact of the pandemic on education. Within this framework, a research opportunity has been found in group orchestration. Education institutions have encountered problems when switching from onsite to online or hybrid learning modes. The tools that teachers and students were used to using were not adapted to the new circumstances. This created several problems, such as teachers and students spending unnecessary time on the activities. Therefore, this PhD proposes techniques and resources to deal with these new emerging problems. One of these resources is Smart Groups, a tool for group orchestration in hybrid learning environments. This tool facilitates and automates many of the orchestration tasks by taking into account the position of the student. It takes into account the safety distance when making decisions and warns users if they do not comply. Finally, Smart Groups has the advantage of remaining useful and performing their tasks in both online or onsite environments.

Keywords

Hybrid learning, Collaborative learning, Orchestration, Smart learning environment, Indoor positioning.

1. Introduction

Terms like Smart Education or Smart Learning Environment (SLE) showed up in the literature about 2014 [1]. In 2019, the definition of these terms was still unclear and there was discussion about it [2]. This happened because of the need to have artificial conceptual aids to create a better idea in a context full of new buzzwords. These terms were influenced by the so-called Industry 4.0 hence its terminology of "Smart" [3]. These terms and works were increasing all over the world [4]. But the works related to these terms had a boom with the arrival of COVID-19 in 2020 [5]. Moreover, the pandemic has led to the emergence of more work on learning in online or hybrid environments. Hybrid learning environments are understood as those in which there are students in the classroom and others online, synchronously [6].

These hybrid learning environments have encountered problems when carrying out collaborative learning activities. These problems were mainly orchestration problems, the amount of time and the lack of specific resources to carry out collaborative activities [7]. For this reason, some online communication applications, such as Skype or Google Meet, started to make changes to adapt to the new circumstances. Some of these changes include increasing the number of users allowed per meeting and improving performance. In addition, some new applications have emerged, such as Zoom, Blackboard or Engageli [8]. Some of these applications have been so important that they have become established in different educational institutions. However, these

Proceedings of the Doctoral Consortium of Sixteenth European Conference on Technology Enhanced Learning, September 20–21, 2021, Bolzano, Italy (online).
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applications have been rather focused on online environments, maintaining some problems in hybrid learning environments. Of these problems, the ones that stand out the most are those related to collaborative learning, such as group orchestration or indoor positioning of students to ensure safe distance [9].

1.1. Research problem

SLEs have worked well in conjunction with collaborative learning [5]. Also, SLEs have been used to try to solve orchestration problems with positive results [10]. In addition, SLEs have been used to try to improve online education [11]. But there is little work using SLEs in synchronous hybrid learning environments. Therefore, the advantages of SLEs in these hybrid environments have not been demonstrated.

In addition, hybrid learning environments are becoming more popular with the pandemic [5]. New works are emerging on collaborative learning in these hybrid environments [12]. But most of these works have a theoretical approach, so there are no results for practical use. Analysis of these works highlights the group orchestration problems that occur in hybrid learning environments [6].

Therefore, a research gap can be identified in collaborative learning and its orchestration in hybrid learning environments. Collaborative learning activities that have these orchestration issues include those in which Collaborative Learning Flow Patterns (CLFPs) are used [13]. CLFPs have shown good results as a way to promote collaborative learning [14] but there is still margin for research when CLFPs are combined with hybrid learning environments.

Furthermore, the pandemic has added new factors to take into account when creating on-site groups, such as safety distance. In some places, the grouping of people would not be allowed if the safety distance cannot be maintained [15]. Taking this factor into account would ensure that collaborative activities would not have to change their dynamics because of this health rule if necessary.

When solutions from previous publications are reviewed, these only address part of the problem, for example, one solution found was the use of robots in the classroom for the "physical" presence of people who are online for collaborative activities [16]. Other papers work on motivation and satisfaction in synchronous hybrid learning environments [17]. There is also literature focused on evaluating the impact of synchronous hybrid learning environments [18]. However, none of these existing publications considers the existing orchestration overload for the teacher.

Considering all these issues, a possible solution would be to develop a tool with the characteristics of an SLE to try to solve orchestration problems, such as group creation, group management or communication. In addition, this solution could include collaborative learning techniques that make use of CLFPs [13]. CLFPs mean a more structured collaboration when the teacher is going to carry out collaborative learning techniques. For some specific cases, collaborative learning techniques using CLFPs give better results than collaborative techniques without CLFPs [14]. For the identification of cases where CLFPs can be used, teachers will be asked to indicate the number of groups or the number of students, if the task to be carried out fulfils certain characteristics (such as if the task to be carried out is divisible, has several solutions and/or has several themes), if teachers are going to take into account the student's previous work data (only if available) to form heterogeneous or homogeneous groups. With this data, a CLFP or the creation of simple groups will be recommended, whichever is best suited to the task. If teachers choose a CLFP, they will have to take into account that they will perform several steps in which the groups will be modified, whereas with simple groups the tasks are always performed with the same group configuration. If teachers want to change the phase of the chosen CLFP, they will have to go to the group management. In the group management the teachers will always be asked if they want to make the change of phase. If the teachers accept, the change of phase will be made, and if the teachers refuse, they can make the necessary changes in the groups. The change of phase of the CLFP will be done automatically. Furthermore, all these functionalities should work in synchronous hybrid learning environments. For these, the tool will provide the necessary resources so that the group can work regardless of where its members are located. These resources can range from a chat room only for the students and another one with the teacher to the possibility of sharing files among all of them. Finally, the tool will take into account the safety distance between users for places that must comply with this health requirement.

As the tool has to be accessible at all times it is conceived as an application for smartphones. For this reason, the target users will be secondary and university students, as students must own a smartphone and be able to operate it without any problems.

The main challenges facing this solution are that the tool helps with orchestration rather than increasing its load, that teachers need to understand CLFPs and that on-site students must use the tool so as not to marginalise those who are online.

1.2. PhD diagram

Figure 1 shows an overview of the PhD, including the context and the research problem, as well as the objectives and expected contributions.

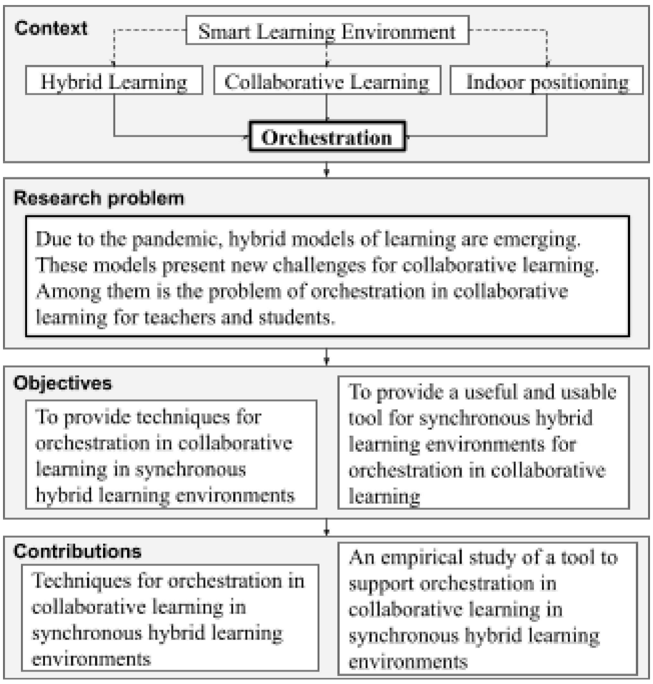

Figure 1: PhD diagram: indicating context, research problem, objectives and contributions

2. Research methodology

Different works were analysed for the research methodology. Among these works, the work of Peffers et al. [20] stood out for its great analysis of different methodologies for information systems. The analysis of this work identified the methodology of Nunamaker et al. [21] as the one best suited to this PhD. This methodology is designed for information systems that need to collect and analyse a lot of information for their elaboration. This methodology takes into account this data analysis in all its phases. These characteristics facilitate the development of the doctorate since there is almost no information on the subject of the doctorate and different ways have to be explored. This methodology consists of different processes which are shown in figure 2.

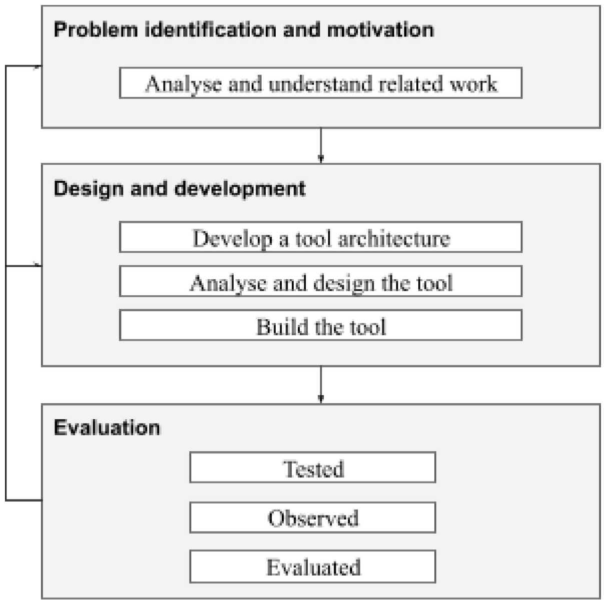

Figure 2: Methodology processes: problem identification and motivation, design and development, evaluation

The first process is problem identification and motivation. In this process, a thorough analysis of previous work is carried out. For this process different research ideas have to be justified, different problems and related research approaches have to be analysed. The second process is design and development. In this process, the architecture of the tool is designed and analysed. Then, according to the analysis, a solution is developed. The last process is evaluation. In this process, the functionality of the tool is tested, observed and evaluated. For testing, a prototype will be made for user observation. The tool will be used in real environments with users for evaluation. The authors define these processes as iterative, i.e. in any process, it is possible to go back to any of the previous processes.

2.1. Problem identification and motivation

A summary of the steps followed in this process of analysis and understanding is shown in Figure 3.

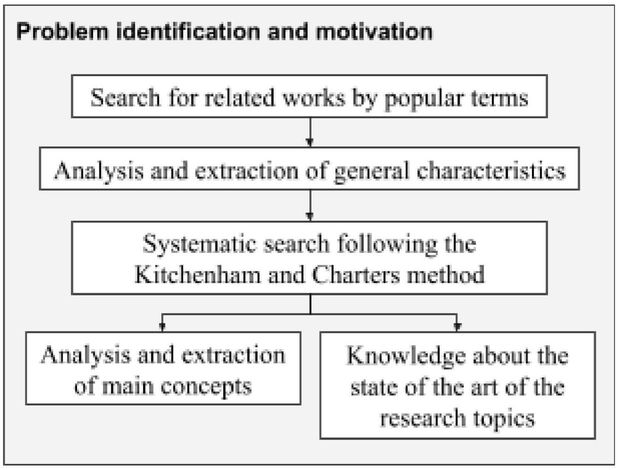

Figure 3: Problem identification and motivation: analyse and understand related work

In the first process of research, a systematic literature review was conducted using popular terms related to SLEs. This search took into account the different terms used in the literature to refer to SLEs, such as Smart Education or Smart Classroom. The other terms were from the educational context, most popular technologies and keywords related to data collection and analysis in smart environments. The next step was another systematic search following the Kitchenham and Charters method [19]. This search focused on empirical work on SLEs. The search analysed the affordances that make a learning environment smart; which technologies are used in SLEs; and in which pedagogical contexts SLEs are used. The paper produced from this joint work with other researchers aims to ensure a relevant knowledge base and a reference for the implementation of future SLEs. Another objective was to try to define SLEs taking as a reference those of Hwang [22], Spector [23] and Koper [24]. This definition was: "*Smart Learning Environments are Technology-Enhanced Learning (TEL) environments that make adaptations and provide appropriate support to learners based on the individual needs and context in order to achieve a better and faster learning*".

While this work on SLEs was being carried out, the COVID-19 pandemic hit the world. As a consequence, some of the classes began to be held with some students on-site and others online in a synchronous manner to respect the maximum capacity allowed in the class. So, it was analysed how SLEs could help in this new situation. SLEs have been shown on several occasions to work well with collaborative learning [5]. In addition, SLEs have also shown good results in solving orchestration problems [10] and in online learning [11]. For these reasons it was decided to try to transfer these benefits to synchronous hybrid education.

The tool must work in both onsite and online learning settings, but especially for hybrid learning. The limitation of the number of students will be given by the architecture that supports the tool, as the automation will help the teacher with the workload. This will allow scaling up by improving the architecture and with only a slight impact on the teacher's workload. Finally, the teacher will have the possibility to modify the groups at any time to achieve the greatest possible flexibility.

2.2. Design and development

A summary of the steps followed in this process of design and development is shown in Figure 4.

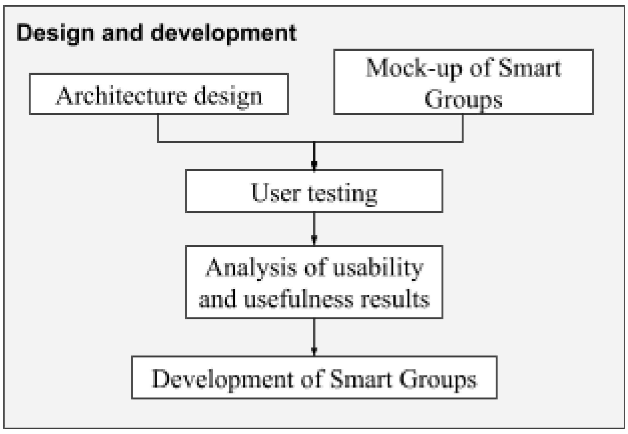

Figure 4: Design and development: architecture, analysis, design and build

After these processes of research and analysis of the related literature, the development of Smart Groups began. In the first stage of development, a design was proposed. But this design did not take into account the ideas of the users, only those of the authors. Therefore, it was suggested to do an early test in order not to have to make changes in the final step of the development of Smart Groups. To test whether this tool was useful and usable for users, an exploratory research study was conducted on a mock-up of the tool. System Usability Scale (SUS) was used to evaluate the usability of Smart Groups [25]. For the usefulness evaluation, interviews were conducted according to the Technology Acceptance Model (TAM) [26].

After this iteration, development of the smartphone application began [27]. Initially, the students' part was developed to detect whether they were in the classroom or not and to show them the map of the classroom according to their group. Then, the teacher's part was developed for the creation and management of groups, and the recommendations of the CLFPs, as can be seen in Figure 5. Once this basic flow was completed, access security, communication tools and file-sharing were introduced. Finally, the user interface was improved and some functionalities were added, such as the search by student name.

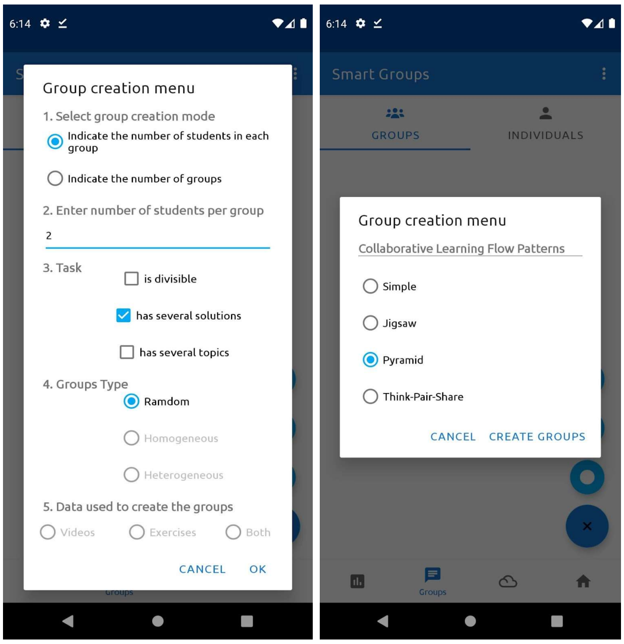

Figure 5: Recommendations of the CLFPs: Teacher form and associated recommendation

2.3. Evaluation

A summary of the steps followed in this process of evaluation and experimentation in a real environment is shown in Figure 6.

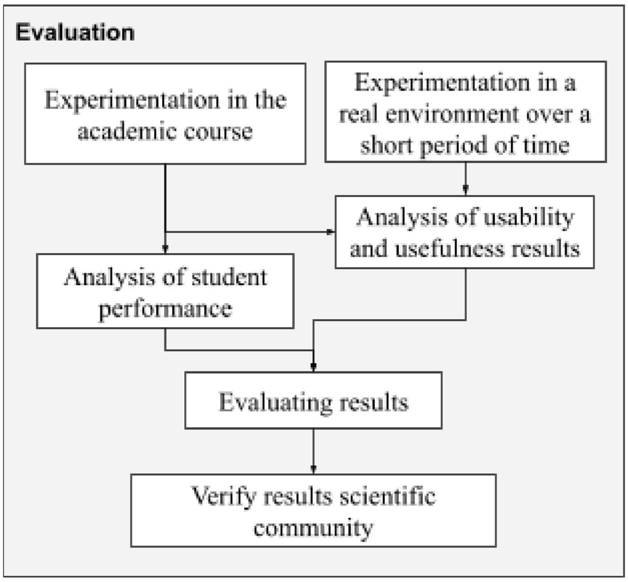

Figure 6: Evaluation: Experimentation, analysis and verification

So far only one iteration of evaluation has been done during development [9]. A SUS questionnaire was administered to 60 users who had performed different activities with the mock-up. These surveys resulted in a mean score of 75.54 out of 100, which is a good result according to SUS. In addition, interviews were conducted according to the Technology Acceptance Model (TAM). These interviews were conducted with 10 teachers who participated in the previous evaluation. The results of the interviews were that the users perceived almost all features of Smart Groups as useful.

A new iteration of the evaluation is currently underway. For the future evaluation, several experiments will be carried out, which will be divided into two types. The first type is of long duration, about four months. A collaborative project will be carried out throughout the whole period in this type of experiment. The second type is of short duration. These experiences will be short, like seminars of a maximum of 2 or 3 days.

From the short-term experiences, it is expected to obtain different approaches to the usefulness, usability, impact of learning and satisfaction of Smart Groups. For this purpose, the SUS [25], TAM [26] and the model proposed by Muñoz-Carril et al. [28] models will be used. In this way, a wider variety of users can be obtained, thus increasing the number of perspectives. Furthermore, this will allow a comparison with the results already obtained in the development phase. In addition, the evaluation of learning impact and satisfaction will provide further information to demonstrate whether Smart Groups is a tool that effectively supports collaborative learning in synchronous hybrid learning environments.

From the long-term experiences, it is expected to obtain the performance, the perception of usefulness, usability impact of learning and satisfaction of the students when using Smart Groups over this long time. For the performance, there will be control groups that will not use the application and the results will be compared to see how much it can influence the performance of the students. For the usefulness and usability part, the same will be done as with the short experiences, with the SUS [25] and TAM [26] models. For the learning impact and satisfaction, the model proposed by Muñoz-Carril et al. [28] will be used. On these results, it will be possible to observe whether there is a difference in using Smart Groups moderately or over a longer time.

Finally, the analysis of these results will be presented in a paper. This paper will be published in a first quartile JCR journal. To confirm that the analysis is done correctly and that it is useful for the scientific community.

3. Future work

This PhD is trying to solve the problem of orchestration in hybrid learning environments, trying to enhance collaborative learning and taking into account security measures for the pandemic. But this is a big problem and there are still issues to be addressed. In addition, some issues are far from the focus of the PhD and therefore have a lower priority to be addressed.

The issue of Learning Analytics has come up a lot during the course of the PhD. So LA is likely to be integrated into the PhD if time permits. This issue can be a good tool to get feedback from students. This information can be used by teachers for decision making, or for gamification issues.

Another issue for the future is gamification. Although some gamification features have been used in this PhD, it is not an issue that has been explored in depth. This issue can contribute to improving collaborative learning. In addition, gamification can facilitate group orchestration by making it a game for students.

Another future work is the incorporation and adaptation of external resources, such as MOOCs or tools for collaborative learning. New resources of this kind come out all the time to solve new problems or to improve old tasks. Therefore, facilitating the incorporation of these resources into a tool in use can help its development and useful life.

An issue derived from the previous one is the incorporation of tasks in Smart Groups. In other words, the teacher can set exercises for the students so that they only need one tool to carry out their collaborative activities.

Finally, this PhD has a practical focus, so it is limited especially in the evaluation part. It is necessary to gather the necessary people for the experimentation, and this is very difficult. Even with all this, it is hoped to be able to improve collaborative learning in hybrid environments and facilitate its use in times of pandemics.

4. Expected contributions

SLEs are slowly growing and are a good research opportunity. There are many problems to be solved in the education of the future. The pandemic has shown that there is much opportunity for improvement. Especially the growth of hybrid and online learning environments. In addition, problems have been encountered in carrying out collaborative learning activities that are time-consuming for both teacher and student.

For these reasons, it is expected that this PhD will make a conceptual contribution to synchronous hybrid learning environments. The aim is to help separate the concept of synchronous hybrid learning environments from that of blended learning so that there is no confusion in the educational community. As part of the empirical contribution, a tool to support orchestration in collaborative learning in synchronous hybrid learning environments will be developed. This tool will seek to enrich collaborative learning with CLFPs and automate the most tedious tasks in group management. In addition, this tool incorporates features to be able to continue collaborative learning in times of pandemic. Finally, an empirical study of how a tool such as Smart Groups can help in these new environments will be conducted.

5. Acknowledgements

This work was supported in part by the FEDER/Ministerio de Ciencia, Innovación y Universidades – Agencia Estatal de Investigación, through the Smartlet Project under Grant TIN2017-85179-C3-1-R, and in part by the Madrid Regional Government through the e-Madrid-CM Project under Grant S2018/TCS-4307 and under the Multiannual Agreement with UC3M in the line of Excellence of University Professors (EPUC3M21), and in the context of the V PRICIT (Regional Programme of Research and Technological Innovation), a project which is co-funded by the European Structural Funds (FSE and FEDER). Partial support has also been received from the European Commission through Erasmus+ Capacity Building in the Field of Higher Education projects, more specifically through projects LALA, InnovaT and PROF-XXI (586120-EPP-1-2017-1-ES-EPPKA2-CBHE-JP), (598758-EPP-1-2018-1-AT-EPPKA2-CBHE-JP), (609767-EPP-1-2019-1-ES-EPPKA2-CBHE-JP). This publication reflects the views only of the authors and funders cannot be held responsible for any use which may be made of the information contained therein.

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