An Integrated Framework for Collaboration in Online Learning Using CSCL Scripts

Nada M. Alharbi, Rukshan I. Athauda, and Raymond Chiong

Abstract—Collaborative learning has proved to be effective in improving cognitive skills (e.g., critical thinking) and acquiring knowledge through group interactions and activities. An active research field known as Computer Supported Collaborative Learning (CSCL) aims to enrich collaborative learning using technologies. These days, online learning environments equipped with various communication tools (e.g., chat sessions, discussion forums, voting, video conferencing, etc.) have been widely used by many higher education institutions. However, the CSCL research community has identified potential issues among online learners, one of which being the lack of productive collaboration in online learning environments. To address these issues, CSCL researchers have suggested the use of CSCL scripts to trigger and structure collaborative learning activities. In this paper, a review of relevant studies on CSCL scripts and the development life cycle involved (i.e., modelling, authoring, deployment, and execution phases) is presented. We found a number of initiatives in tools and platforms developed to create CSCL scripts for specific collaborative scenarios. It is evident that the development of CSCL scripts is still evolving and many hurdles need to be overcome before educators and learners can utilise such tools and platforms in a ubiquitous manner. In particular, many of these tools and platforms appear to be complex and difficult to use (e.g., a certain level of technical skill is required). To remedy some of the complexity involved in various tools and platforms used across a number of phases in CSCL script development, we propose a framework that integrates the development and execution of CSCL scripts into a single, user-friendly environment. The main objective of our research is to minimise the complexity in developing and executing CSCL scripts for online collaborative learning scenarios.

Index Terms—Collaborative learning, CSCL scripts, online education.

I. INTRODUCTION

Collaborative learning is an effective way to encourage students in the learning process to achieve learning goals. The positive impacts of collaborative learning are well documented in the literature [1, 2]. There is a historical relationship between Information and Communication Technology (ICT) tools and collaborative learning in facilitating the learning process. Collaborative learning and ICT tools have been used in different levels/contexts in education (K-12, graduate studies, etc.) [3], and this has led to the emergence of the term Computer Supported Collaborative Learning (CSCL) [4]. Over the past two decades, there has been increased interest in using technology to support collaborative learning. The main goal of CSCL is to encourage students to construct knowledge in a rich interactive environment.

Even though a wide range of studies on promoting collaborative learning environments can be found in the literature, student engagement and uptake in these learning environments is still poor. Students often fail to perform collaborative tasks in an appropriate way and this would affect their abilities to achieve learning goals and meet pedagogical objectives. This issue is particularly evident among online learners who are missing real-world contact and non-verbal communication such as body movement and facial expression.

To promote more effective collaborative learning, CSCL research suggests scaffolding and structuring the collaborative learning process. A learning strategy based on the use of CSCL scripts, which are predefined scenarios to regulate student interactions throughout the learning process, has been introduced [5]. The aim of this strategy is to promote student engagement, and gain knowledge and social skills through the pre-defined structured collaborative methodology.

However, tools and platforms that have been used to develop CSCL scripts for specific collaborative scenarios are still practically premature. While CSCL researchers have continually proposed different tools and pedagogical script methods to facilitate CSCL script development and execution, there exist complexities in using them and uptake on the actual utilisation of such tools/platforms has been low. The main objective of this work is to minimise the complexity of developing online collaborative learning scenarios. We therefore propose a framework to facilitate the design of CSCL scripts (for educators) and their execution in an online environment. This framework integrates the different CSCL script development phases (see Section III) into a single environment incorporating recent pedagogical and technological scripting methods.

The rest of this paper is organised as follows. Section II presents some general background of related fields, which include online learning, collaborative learning and CSCL as well as the challenges faced by online learners in CSCL environments. A review of current issues during the development of CSCL scripts is then discussed in Section III. Following which, an integrated framework is proposed in Section IV. Finally, Section V concludes the paper with some discussion on future work.
II. BACKGROUND

A. Online Learning

Online learning has become an essential need in modern society. It involves the accessibility of learning material through the Internet. Some literature also refers to this mode of learning as e-learning. However, e-learning is a broader concept than online learning. In addition to delivering learning via the Internet, e-learning also involves the use of digital tools such as TV, CDs, and videotapes, among others [6, 7].

Some research (see [8] and chapters therein) has shown that online learning is an evolving trend in recent times. This is because of the flexibility to deliver learning material and study regardless of time and location constraints. As a result, there are increasing needs for improving online learning through various tools and environments such as Learning Management Systems (LMSs), Content Management Systems and Virtual Classroom Systems. The emergence of advanced technologies over the last few years has had many positive influences in online learning environments. For instance, cloud computing [9] and its features for expanding and supporting higher education’s infrastructures have led to the possibility of Massive Online Open Courses (MOOCs) [10]. MOOCs provide university-level courses in an open, online environment that is freely accessible by learners from all around the world at any time. In addition, Mobile Learning (m-learning) is a new trend of learning that incorporates the latest emerging mobile devices and wireless technologies in a flexible way so that learning can occur through these devices. These kinds of learning have become convenient, as learners can access learning materials at any time in a rich interactive environment using a device of choice.

However, several educational institutions that offer online courses and programs have reported a significant number of students withdrawing and dropping out courses. Statistics based on the MOOCs revealed that less than 10% of learners actually completed the requirements and received a qualification [11]. Different studies have discussed the challenges faced by learners that result in them not completing courses online. Some researchers (e.g., [10],[12]) argue that isolation, lack of interactive media and insufficient guidance can have an effect on students’ engagement and motivation in such online courses. Further discussion of these challenges will be explained in Section II.C.

B. Collaborative Learning and CSCL

According to Dillenbourg [13], it is difficult to provide an exact definition for the term “collaborative learning” as the purpose of collaboration changes depending on pedagogical goals and cognitive objectives. Simply put, it could be defined as two or more people working and discussing different ways to accomplish the same goal. Over the last decades, considerable research has been done in developing theories and technologies that enrich collaborative environments. Dillenbourg [13], for example, describes the theory that collaborative learning is based on sharing social and intellectual interactions. Going through the collaborative process such as discussing perspectives, distributing and sharing tasks, and receiving peers’ feedback will potentially create new knowledge. Collaborative learning is an effective way to encourage participants in the learning process to achieve learning goals. Moreover, there are some soft skills (e.g., leadership, management, productivity) as well as learning outcomes that cannot be achieved without triggering certain collaborative mechanisms, such as joint problem solving, brainstorming, group debate, voting, etc.

CSCL is an active area of research, in which different technologies and innovations have been applied to collaborative learning. Both the software engineering and education domains have contributed to the CSCL research in enhancing the collaborative learning process and its environments. The education domain contributes mainly to the theoretical aspects of CSCL, such as providing useful frameworks for applying collaborative patterns, analysis of learning processes and social interactions. Meanwhile, the software engineering domain contributes to the technological aspects such as developing interactive environments, applying ICT tools and designing application paradigms. Involvement of both domains enhances the effectiveness of CSCL systems.

C. Challenges in Online CSCL Environments

Many challenges in regard to CSCL environments have been discussed in the literature, especially when collaborative learners are given the ownership of their learning process. In a typical free online collaborative scenario (see Figure 1), collaborative learners are expected to understand and share learning contents as well as use communication tools effectively. For example, a teacher provides a group project to students with the aim to improve their critical analytical skills (the planned pedagogical goal). The teacher asks a group to brainstorm about the best mode of generating electricity in a remote farm. Here, the teacher would expect each member of the group to propose ideas, discuss their thoughts with other group members, analyse and nominate the best way(s) to generate electricity. However, just giving the students a set of communication tools (e.g., chat sessions, voting tools, discussion forums, etc.) does not guarantee that the brainstorming process will be carried out as expected. The students may misuse the collaborative tools or they may not go through the steps required (e.g., proposing ideas, discussing, analysing and nominating the best electricity model) for fruitful brainstorming. Hence, this will affect the students’ ability in meeting the planned pedagogical goal (i.e., critical analysis). We will revisit this example in Section II.D to show how a CSCL script approach can help to overcome the problem of achieving productive collaboration under a free online collaborative scenario.

Various issues have been discussed in previous research studies related to free online collaborative scenarios. Researchers have consistently emphasised on the importance of implementing an effective CSCL environment in order to improve students’ engagement in productive learning interactions. For example, Dillenbourg et al. [5] discussed issues about students’ engagement and concluded that without
external support and direction such as teachers, system prompts and instructional sheets, a productive collaborative session could not be achieved in most cases. The lack of beneficial collaboration among online learners is particularly evident compared to others (such as those in blended learning environments) due to limited real-world contacts by learners and the freedom to use collaborative tools without sufficient support. Several researchers (e.g.,[12][14]) have stressed that the challenge to deliver successful collaborative online learning is greater than other learning modes (e.g., face-to-face and blended learning). Hence, external support is required to increase the possibility of achieving the desired interactions. In other words, merely asking students to collaborate and giving them the communication tools may not necessarily lead an effective collaborative process even with recent emerging collaborative environments and platforms such as Web 2.0.

A number of challenges surrounding free online collaborative scenarios are summarised as follows:

- Lack of time management: In an online learning mode, the learners may not adhere to specific time to carry out their tasks (e.g., any time of the day or night) and as a result, it affects their participation with peers.

- Feeling of isolation: Online learners are isolated physically from each other and as such they would often rely on others to initiate the collaborative process. This can have a negative impact on achieving motivational collaboration.

- Lack of guidance: Usually, teachers are there to support collaborative learning within face-to-face classes but in the online mode, it is the learners’ responsibility to collaborate appropriately. This can lead to misunderstanding the required collaborative tasks as well as misusing the communication tools.

- Insufficient inclusion of engagement factors: Several reasons can affect students’ engagement such as lack of interactive learning platforms, absence of or not enough external support and instructions, poor design of collaborative activities, etc. As a result, online learners are not motivated to collaborate with each other.

- Active social life: Unlike traditional students in the past whose main occupation was education, today the majority of the students are engaged in too many activities at the same time, e.g., a part-time or full-time job, which may impact a student’s concentration/ability to participate in required collaborative tasks [14].

To address some of these challenges, structured and scaffolding interactions among learners have been introduced by the CSCL research community through the use of CSCL scripts. Scripting is an approach that assists teachers to apply pedagogical scaffolding theories to CSCL environments in a user-friendly way, in order to improve collaborative learning using computer-supported tools. The next section describes CSCL scripts and the mechanisms for addressing the challenges in free collaborative online scenarios.

D. CSCL Scripts

Scaffolding interactions among students is helpful for them to coordinate tasks and to acquire a proper pedagogical outcome (e.g., critical thinking), similar to a tutor’s role, which guides collaborative interactions among learners. Nevertheless, it is not essential for a teacher to continually monitor the low-level interactions between students. Instead, providing a detailed specification of the collaborative scenario helps to foster productive interactions by exchanging necessary complementary knowledge as well as achieving pedagogical outcomes (e.g., critical thinking and social skills). This is made possible through the use of collaborative scripts [15].

Collaborative scripts are predefined scenarios that deliberately promote productive interactions among learners as well as fruitful peer engagement. Structuring of collaborative processes through scripts is typically done beforehand in order to determine individual roles within groups, the sequence of activities and the setup of required communication tools within a collaborative environment. Also, teachers who initiate a specific collaborative task have planned learning objectives and pedagogical outcomes that they want a learner to gain through the task. Going back to the previous example about generating electricity in a remote farm discussed in Section II.C, for instance, the students did not meet the planned pedagogical goal due to their unstructured way of collaboration. However, if the teacher structures the collaborative task by dividing the brainstorming process into subtasks, the planned objective (critical analysis) could be achieved. The teacher will get the students to do brainstorming on subtasks one by one instead of simply asking them to deliver the best model for generating electricity without knowing if they had gone through the proper brainstorming process. Specifically, the teacher can ask the students to first propose a list of best models of electricity generation, and then discuss the proposed models within a group before voting and selecting the best choice while also justifying the selection. Based on this structured scenario, the students will be able to go through the brainstorming process step by step and this will help improving their critical analytical skills and achieving the planned learning objective.

The CSCL approach supports the provision of technological means required for the development, management and use of collaborative scripts. It would be quite cumbersome to develop and manage collaborative scripts manually by educators or
script designers. As such, several studies (see Section III) have attempted to develop tools and platforms to support automation or semi-automation deployment and management of collaborative scripts. Collectively, they are known as CSCL scripts [16]. According to Dillenbourg [5], CSCL scripts can make a collaborative environment more dynamic in a number of ways:

1. A group formation may change in different ways during a collaborative session, e.g., from peer-level activities to individual activities and then group-level activities.
2. Providing different communication tools for different collaborative learning situations, e.g., a group nomination scenario needs different communication tools than the tools required for a brainstorming scenario.
3. Providing feedback for specific group interactions.
4. Selecting an appropriate communication tool to use depending on the needs of a collaborative task.

When collaborative scripts are implemented in a CSCL environment, this will contribute to reducing a teachers’ workload during the process of deploying the collaborative scenario [17]. However, several issues (e.g., adaptive, automation, monitoring, orchestration, etc.) exist in delivering an ideal CSCL environment that supports self-managed scenarios, and some recent studies have looked into solving these issues (e.g., see [18, 19]). Also, designing and deploying CSCL scripts can be a daunting task for educators and script designers who do not have the necessary programming and technical skills. It is therefore important to investigate and develop tools that can support non-expert users in designing and executing CSCL scripts. An analysis of the phases involved in the development life cycle of CSCL scripts and associated tools used is outlined in the following section.

III. ANALYSIS OF CSCL SCRIPT DEVELOPMENT PHASES

In this section, we analyse and examine some issues related to CSCL scripts during the development cycle. The goal behind CSCL script research is to deliver a user-friendly environment for non-expert educators and script designers who do not have technical and programming background to design and execute collaborative scripts [20]. After reviewing a number of CSCL development projects in the literature, we propose to view the CSCL development life cycle in four main phases:

1. Specification and formalisation of modelling languages: This phase attempts to select or create a formal model or specification language that enables educators to design their own CSCL scripts in a way that is compatible to a CSCL system or environment.
2. Authoring and designing: Using the specifications (e.g., languages, graphical notation, etc.) from the previous phase to design the actual collaborative script.
3. Deployment: Prepare for the collaborative script to be executed, e.g., allocate participants and assign roles and tasks to them. Some researchers [21] refer to this phase as managerial roles for coordination between participants and CSCL scripts.
4. Enactment: The last phase is to execute the CSCL script within a LMS or any selected collaborative environment.

Every phase of the CSCL life cycle has attracted significant interest in academic research. Here, we will identify issues, current tools, their limitations and complexities related to each phase.

The first phase is about preparing and converting collaborative scripts into machine-interpretable format. Formalisation and computational representation for different CSCL scripts have been investigated using different approaches. For instance, graphical representation modelling was discussed by Harrer et al. [22], and they developed a prototype that corresponded to graphical notation. Besides that, the Educational Modelling Language (EML) [23], which presents a different way of formalising and representing collaborative scripts, has been extensively discussed and debated among researchers. Arguably, many EMLs have been utilised and deployed, but an agreement on similar standards of architecture is yet to be finalised. For example, in 2002 PALO EML was developed by Rodriguez-Artacho et al. [24]. Another formal model was used by Martel et al. [25] in 2004, which presented a novel educational meta language to illustrate a collaborative setting called the Learning Design Language (LDL). IMS Learning Design (IMS LD) was proposed by Open University in the Netherlands [26, 27], and it is widely used to describe the specification for CSCL scripts. In fact, it is currently considered a de-facto standard for CSCL scripts. Furthermore, a series of research studies have extended IMS LD [18, 28, 29].

As explained before, representing collaborative scripts in machine-interpretable format has been studied and several EMLs have been proposed (e.g., IMS LD). The problem, however, is that these EMLs use formalisms (XML tags and structure) that are not readily interpretable by educators. The majority of the CSCL script designers or educators would not be familiar with these meta data languages. This is a major obstacle for the use of CSCL scripts. To tackle this issue, CSCL researchers have strived to design environments that allow educators to easily specify, understand, create and use CSCL scripts. Providing authoring tools will also help in concealing the complex specification of EML.

Presently, several authoring tools that aim to fill the gaps between non-expert users and EMLs have been developed to design learning scenarios in a formal manner. For instance, the COLaborative LeArning desiGn Editor (COLLAGE) [28] provides a set of collaborative learning scenarios or a specific Collaborative Learning Flow Pattern (CLFP) (e.g., think pair, JigSaw, Pyramid) that can be applied for any learning subject. This tool is designed specifically for non-expert users and also incorporates specific characteristics for collaborative learning. The patterns are implemented using IMS LD and this learning design may lead to a successful collaborative script when applied under certain circumstances. WebCollage [18] is an extended version of COLLAGE with assessment scenarios incorporated that are also IMS LD compliant.

Various techniques can be employed to support non-expert educators and to hide programming complexity during the design phase, such as CLFPs and graphical representation of collaborative scenarios. However, these techniques are still in
their initial development stages and further research on them will be beneficial for the design of collaborative scripts.

During the deployment phase, various tasks and operations need to be finalised before starting collaborative scenarios. For example, the operations could include selecting members, specifying communication tools and allocating learning contents for a collaborative learning session. As there are different kinds of authoring tools and a variety of EMLs to use for designing collaborative scenarios, the challenge lies in how to configure and execute such collaborative scenarios in different learning environments (e.g., Wiki, Moodle, etc.). An analysis of relevant studies suggests that configuring the CSCL script within well-known LMSs or Web 2.0 services seems to motivate teachers to improve their collaborative learning sessions. However, we found only two tools, Glue-PS and CADMOS, which have started to implement this idea. Glue-PS developed by Prieto et al. [30] offers a framework to deploy a variety of learning designs to a number of learning environments and tools (such as Blogs, Google Docs or any other Web 2.0 services). To illustrate the possibility of implementing their framework, Prieto et al. in their subsequent work [31] also demonstrated how IMS LD can be configured and used in the Moodle environment. A potential challenge here is having teachers to use three different environments from authoring to enactment, making it a complex process that might affect the quality of CSCL scripts. Katsamani and colleagues [32] have realised this issue, and they designed the CADMOS tool by combining the authoring and deployment phases so that it can map the designed CSCL script into the Moodle LMS. However, the work is still in its early stages and further development is required.

Regarding the last phase (i.e., enactment), applying designed CSCL scripts into generic, well-known learning platforms is seen to be more convenient for teachers as well as increasing motivation among students to collaborate. Because of this, some learning platforms that are developed specifically to execute CSCL scripts, such as LAMS [33] and Gridcole [29], do not get widespread adoption among teachers, even with their unique features. Other features, such as monitoring, ubiquitous-learning, orchestration and adaptive techniques, are also important and need to be considered during the enactment phase.

IV. AN INTEGRATED FRAMEWORK

To facilitate the development of collaborative learning scenarios by educators in order to enhance the learning experience of online collaboration, we propose a framework that combines CSCL script life cycle phases (designing, deployment, enactment) into a single environment and utilises recent communication technologies with emerging pedagogical script methods for online collaborative scenarios. This framework consists of three main layers. These layers are the authoring, deployment and orchestration layers as illustrated in Figure 2. The proposed framework has several distinctive features. One of the features is to combine the designing and deploying phases of the CSCL script development life cycle into a single environment in order to reduce the complexity of the entire process. The second feature is to enhance the execution phase by integrating popular collaborative tools such as Web 2.0 technologies. The orchestration of collaborative activities during the run time is one of the obvious challenges that several studies have discussed, hence this final feature will include techniques that support teachers to orchestrate learning activities among online learners.

V. CONCLUSION AND FUTURE WORK

In this paper, online and collaborative learning have been highlighted as two important trends in the education domain. However, it is evident that engaging online learners to achieve a productive collaboration process is a challenge. This is due to factors such as misuse of communication tools, low engagement, and tools used by educators to create scenarios being not user friendly. As a result, planned learning objectives...
are often not achieved.

As a step forward, we introduced an integrated framework with features to facilitate the development of productive collaborative scenarios by educators that will engage online learners to carry out collaborative sessions in an interactive environment with useful guidance. The next stage of our research will be to implement the proposed framework and verify its efficacy on real online collaborative scenarios.

REFERENCES


