Learning Analytics in Collaborative Online Lab Environments: A Systematic Scoping Review

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ABSTRACT: With the increase in online education arises the challenge of replicating physical laboratories and teamwork online. This poster presents a brief overview of a scoping review of the current research within the area of learning analytics and collaboration in online laboratory environments, including results on the used learning analytics method. A gap of knowledge in the current research where there is a lack of research addressing this topic has been identified. This calls for the need of further research within this area.

Keywords: Collaboration, Learning Analytics, Online Laboratories, Online Learning

1   INTRODUCTION

The importance of technology in education is increasingly growing. The momentum has been evident after the outbreak of the COVID-19 pandemic when typical in-person classroom teaching was suspended worldwide and the educational systems were forced to move into virtual environments. In biosciences, where laboratory sections are at the core of undergraduate education, finding a feasible way of conducting laboratory work in a virtual space is challenging, yet crucial. The challenge is represented by replicating hands-on exercises and teamwork online to meet the pedagogical standards of university discourses and the desired outcome of such exercises. The progress within technology and communication networks has made it possible to develop virtual and remote laboratories that allow students to conduct experiments online and find a way around the limitations of physical laboratories (Alkhaldi et al., 2016). Collaboration and teamwork are at the heart of the common practice in physical laboratories (Teng et al., 2016). With the increase in teaching and learning online, the challenge of facilitating cooperative learning emerges in these online environments. The work of which learning analytics acts to better understand learning performances during collaboration. Learning Analytics may offer students and teachers insight into the interactions within a group. Such information benefits teachers to facilitate their teaching to each group, and students to self-reflect during collaboration. As a part of a master thesis work on this area, and to investigate current research regarding the use of learning analytics in online laboratories and collaboration, a systematic scoping review has been conducted, providing an overview of the volume and nature of existing literature on the given topic. Methods within learning analytics are identified and gaps of knowledge are discussed. Online laboratories will be used as the common term for virtual and remote labs.

2   STATE OF THE ART

The established query string for our search is *(learning analytics) AND (virtual lab* OR online lab* OR digital lab* OR remote lab*)*, which resulted in 419 articles using ELSEVIER Web of Science digital

database. We followed PRISMA guidelines by scanning abstracts of the results and then full-text scanning for those fulfilling the criteria. The inclusion criteria were expanded to online learning environments, as few studies address all the factors of the given topic: collaboration, learning analytics and online laboratories. Only 11 articles were selected for the review. Because of the limited space of the poster, we uploaded the included studies via this link https://bit.ly/3E0qx7k

The results from the review revealed few studies addressing all the factors of the given topic: collaboration, learning analytics and virtual/remote/online laboratories. Romero et al. (2015) provides an example of the use of learning analytics in the Weblab-Deusto remote laboratory platform. A software layer over the platform registers data regarding the students' interactions with the experiment, recording clicks and traces within the system and storing it in a database. The analyzed data are presented to both teacher and student through a software showing differences and similarities between the exercises performed by the student compared to the teacher's execution. It is stated that such data can be processed for both individual students and groups of students, however this study focuses primarily on the performance of the individual student. Qvist et al. (2015) present a similar example of learning analytics use in the LabLife3D virtual laboratory environment where they store data of student mouse clicks and time spent on tasks. The analyzed data are presented through timelines of data trails from the executed experiments, enabling teachers to identify occurring errors and students to reflect on their learning process. These laboratory experiments also do not yet provide collaboration amongst students as they focus primarily on the individual learner. The collaboration of students has been further investigated by Orduña et al. (2014) in the same Weblab-Deusto remote laboratory platform as in Romero et al. (2015). Social network analysis was applied to analyze data on uploaded files to the system, as the platform does not store interaction data between students. By checking files shared among students, one can identify who is sharing with who, and who is receiving. This information allows teachers to establish those in need of help, as students who often receive files might be struggling.

There are few remote laboratory environments that allow collaboration within the system, however, Teng et al. (2016) developed one that does. The NetLab remote lab allows students to use the system at the same time as other students and provide them with a built-in chat window for communication. All actions made by students online are broadcasted in their own window. The planned future work of their study is to employ learning analytics methods to analyze those data.

Several research papers regarding discussion forums have been identified. In a more recent study, Doleck et al. (2021) measure the performance of social learning networks in discussion forums through an algorithm which offers to optimize these networks by connecting users with similar tendencies. Pillutla et al. (2020) demonstrate a different example of learning analytics in discussion forums through text classification. A central part of learning analytics is the visualization of learner data. An example of this is presented in Tarmazdi et al. (2015), where the authors have developed a learning analytics dashboard for teamwork in an online computer science course. By combining Natural Language Processing (NLP), information retrieval techniques, and sentiment analysis, the dashboard provides monitoring and analysis of the roles within each group. This allowed the teacher to identify struggling students and teams by looking at how the teams engage in the work.

3   DISCUSSION

There is an apparent knowledge gap within the research of learning analytics in online laboratories and collaboration in labs. Many of the identified studies have not sufficiently developed learning analytics approaches, collaboration, or both. The lack of research in this area could result from the lack of collaborative online laboratory environments. Five years ago Teng et al. (2016) stated that few such environments allow collaboration within the system. This lack seems to persist, given that the results of this scoping review support this claim. Looking at the current work of learning analytics and collaboration in other online learning environments is therefore essential as they provide examples of how it might be implemented in an online lab environment. The most common topics identified in the studies include social network analysis and natural language processing, suggesting these methods are valuable in the analysis of collaboration and are potentially applied in understanding collaboration in online labs. The knowledge gap in this scoping review identifies collaboration in online labs as an area for further investigation.

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