Enhancing Student Learning in OpenSTEM Labs through Live Support: The Lab Assist Project

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Abstract. This paper presents the Lab Assist project, a two-year initiative at the Open University, focused on enhancing real-time support for students engaged in OpenSTEM Labs (OSL) activities. The project explores the feasibility of real-time support mechanisms. The research includes an in-depth literature review, emphasizing self-regulated learning, live chat technology, cognitive load theory, and real-time collaboration in virtual laboratories. Survey findings from module chairs underscore the diverse experiments benefiting from real-time support, emphasizing the need for flexible solutions aligned with faculty priorities. The paper also outlines pilot live support sessions and future initiatives. Key aspects such as platform selection, staff assignment, scheduling, resource preparation, and feedback collection are discussed in the context of implementing an effective live support system. The paper concludes with a reflection on developing and testing a prototype in 2024, aiming to provide a dynamic, responsive, and accessible support ecosystem within the Open STEM Labs, ultimately enriching the learning journey for all students.

Keywords: Flexible support solutions, Lab Assist project, Live chat technology, Live support, Online STEM education, OpenSTEM Labs (OSL), Open University (OU), Pilot live support sessions, Prototype development, Real-time support.

1 Introduction

Lab Assist is one of two Enhanced OpenSTEM Labs (OSL) projects aiming to broaden the range of applications and uses of OpenSTEM Labs. The purpose of this two-year funded project is to investigate how enhanced real-time support can be provided to students conducting OpenSTEM Labs activities. Currently, support occurs by a number of mechanisms that are often asynchronous and vary across areas of OSL activities. The concept behind the Lab Assist project is to provide real-time or near-real-time support to students that are having difficulty completing OSL experiments. The project is intended to particularly benefit students with disabilities who may find it more difficult to participate in practical activities without support and also those with additional needs that are a barrier to participation and could contribute to reducing the attainment gap for disadvantaged students. Although the focus is intended to be on students with

additional needs, there is potential for broader applicability, depending on what solutions are developed.

The Lab Assist project spans a two-year timeline. The first phase of the project is primarily a research and data gathering exercise and included the trial of a support tool. The objective was to extract information that will guide the development of a real-time support mechanism. We collated and analyzed information about previous real-time support activities in the OSL and the Open University (OU) more widely that might contribute to the project. Then, we investigated possible solutions to provide real-time student support in the OSL and we identified possible solutions to deliver real-time student support through the 'Lab Assist' project. Phase two of the project will focus on the development and deployment of a real-time support system that will be flexible and scalable. The aim is to develop trial solutions for proof of concept by testing real-time support on a variety of modules and evaluating the effectiveness of the trial support solutions. Specifically, the outcomes are envisioned to be one or more systems that will assist students who request and need additional support. Larger scale trials will be carried out with the prototype system(s). There is a desire to incorporate some level of algorithmic approach within associated software, but the project is initially focusing on human support. If software capabilities can be introduced to at least reduce the human workload, then options will be explored.

Throughout the project, we work closely with colleagues with responsibility for student experience and support to ensure that the proposed approach is consistent with wider Faculty's priorities and frameworks. The OSL deliver more than 150 practical learning experiences on more than 40 taught modules in the faculty, providing a key element of our practical teaching and has had more than 55,000 users since 2014.

2 Literature review

In this section, we summarize the key findings and insights from the literature search conducted as part of the Lab Assist Project. The literature search aimed to explore relevant studies and research related to the project's focus on real-time support for students in practical learning environments, particularly in the context of online STEM labs and software engineering education. The following subsections provide an overview of the literature findings.

2.1 Self-regulated learning and help-seeking

The literature search highlighted the importance of self-regulated learning and help-seeking behaviors in online learning environments. Students in remote or online settings often rely on asynchronous communication methods, such as email and discussion boards, to seek assistance (Kitsantas & Chow, 2007; Koc & Liu, 2016). This asynchronous nature can lead to delays in receiving help, potentially hindering students' progress (Koc & Liu, 2016).

2.2 Live chat technology for academic help

One significant finding from the literature was the potential of live chat technology to enhance academic help-seeking in higher education, particularly in online and blended learning environments. Students expressed positive responses to live chat technology, highlighting its ability to provide instant, real-time, and convenient assistance (Carter et al., 2017). Compared to traditional face-to-face communication, online learners found live chat to be a valuable alternative (Broadbent, 2020). The use of live chat could bridge the gap in synchronous, private help-seeking between students and teachers in higher education (Cheng et al., 2013).

2.3 Cognitive load theory

Cognitive Load Theory (CLT) emerged as a crucial concept in the literature search. CLT emphasizes the need to manage cognitive loads effectively to optimize learning outcomes (Kalyuga, 2012). The theory differentiates between intrinsic and extraneous cognitive load, highlighting the importance of minimizing extraneous load through instructional design (Sweller et al., 2011). Strategies to reduce extraneous load include eliminating redundancy, managing split attention, and considering the transiency of information (Kalyuga, 2012).

2.4 Real-time collaboration in virtual laboratories

The literature revealed studies on real-time collaboration in virtual laboratories, emphasizing the benefits of synchronous interactions for students (Jara et al., 2009). Collaborative e-learning systems that allow students to share experiences while practicing experiments in real-time were discussed (Jara et al., 2009). These findings underscored the potential of real-time support and synchronous interactions in enhancing the learning experience.

The existing literature highlights several potential advantages associated with synchronous interaction in distant educational settings. Synchronous interaction, often facilitated through live chat technology or virtual classrooms, offers real-time communication and collaboration, providing students with immediate access to support and fostering a sense of community (Bülow, 2022; Belt., 2023). This can be particularly beneficial in situations where timely assistance is crucial, such as during complex experiments or when students face challenges that require immediate clarification.

Furthermore, studies have shown that synchronous interaction can enhance student engagement and satisfaction, creating a more dynamic and interactive learning environment compared to asynchronous communication methods (Broadbent and Lodge, 2021). The immediacy of synchronous interaction can address students' queries promptly, reducing potential delays in their learning progress (Koc & Liu, 2016).

The literature search findings provide valuable insights into the potential impact and benefits of real-time support in online STEM labs, aligning with the Lab Assist Project's goals and objectives. As part of the gathering exercise, we sent a survey to all module chairs who are involved in OSL, so that we could identify the experiments that will benefit from real-time support.

3 Research methods and tools

In this section, we provide an overview of the research methods and tools employed in the Lab Assist project, discussing their selection criteria and their contributions to the study's validity and reliability.

3.1 Literature review

The Lab Assist project initiated with an in-depth literature review focusing on self-regulated learning, live chat technology, cognitive load theory, and real-time collaboration in virtual laboratories. The literature review was chosen as the starting point to establish a theoretical foundation and to understand the existing landscape of real-time support in educational contexts (Booth et al., 2016). By exploring these key areas, we aimed to inform the development of a support system grounded in established educational theories.

The literature review enhances the validity of the study by ensuring that our project aligns with established educational principles (Boote and Beile, 2005). It contributes to reliability by grounding our research in a solid theoretical framework, thus providing a robust foundation for subsequent phases of the project.

3.2 Survey of module chairs

A survey was conducted among module chairs to gather insights into experiments within OpenSTEM Labs that could benefit from real-time support. Surveys are a common method for collecting quantitative data and understanding stakeholder perspectives (Ponto, 2015). Surveys were chosen as a quantitative method to collect data from module chairs. They allowed us to understand the diverse nature of OSL activities, identify priorities, and ensure that the project aligns with faculty goals.

The survey contributes to validity by capturing the perspectives of module chairs, who play a pivotal role in curriculum design and implementation. This method enhances reliability by ensuring that the real-time support mechanisms address the actual needs of module chairs and, consequently, the students engaged in OSL activities.

3.3 Pilot live support sessions

The project involved a pilot trial, using Adobe Connect for live support sessions during a specific module (T229 in Mechanical Engineering). Pilot studies are commonly employed to test the feasibility of an intervention before full-scale implementation (Aschbrenner et al., 2022). Adobe Connect was chosen for its real-time communication and screen-sharing features, aligning with the interactive and dynamic nature of educational support (Elekaei, 2022).

The pilot trial enhances the validity of the study by allowing us to assess the effectiveness of live support sessions in a controlled setting. It contributes to reliability

by providing insights into potential challenges and facilitating informed adjustments before broader implementation.

3.4 Feedback collection

Feedback from the pilot T229 live support sessions, including tutor feedback and recommendations, was systematically collected. Systematic feedback collection is a recognized method for gaining insights into the effectiveness of educational interventions and making informed adjustments. It aligns with the need to understand the experiences and challenges faced by both tutors and students during live support sessions.

The systematic collection of feedback enhances the validity of the study by incorporating the perspectives of those directly involved in the pilot sessions. It contributes to reliability by informing iterative improvements based on the experiences and insights gathered from the pilot trial.

4 Key survey findings from module chairs

The survey conducted among module chairs aimed to identify experiments within OpenSTEM Labs (OSL) that could benefit from real-time support. The survey questions are provided in the appendix. Several key findings emerged. Module chairs identified a variety of experiments conducted within OSL that could potentially benefit from real-time support. These experiments spanned multiple disciplines and highlighted the diverse nature of OSL activities. Module chairs expressed a need for real-time support mechanisms to enhance the learning experience of students engaging in OSL experiments. They emphasized the importance of timely assistance, particularly for complex or challenging experiments. There was a consensus among module chairs that implementing real-time support could positively impact student learning outcomes. They believed that such support could improve understanding, confidence, and overall engagement with OSL activities. Module chairs highlighted the importance of flexibility in designing real-time support solutions. They emphasized the need for solutions that can adapt to the unique requirements of different experiments and accommodate a range of student needs. While there was interest in incorporating algorithmic approaches to support, the initial focus was on providing human support. Module chairs expressed a preference for human assistance but acknowledged the potential benefits of algorithmic assistance in the future. The project's alignment with wider Faculty priorities and frameworks was considered crucial. Module chairs emphasized the need for consistency with the faculty’s goals and the importance of collaboration with colleagues responsible for student experience and support. Overall, the survey results provided valuable insights into the potential impact of real-time support within OSL and highlighted the diverse nature of experiments that could benefit from this initiative. The findings will inform the development and implementation of real-time support mechanisms in the Lab Assist project.

5 Pilot live support sessions

Following the survey and analysis, several activities have been selected for focused attention, prioritizing those most likely to benefit from (near) real-time support. These activities were designated as priority 4 or 5 in the real-time support table, considering factors such as inclusion in assessments, pair/group work, multi-stage experiments, and more.
In the provided survey, the priority of activities for real-time support is not explicitly defined in a structured table. However, by examining the responses and comments from module chairs, we can identify some factors and considerations that contribute to the prioritization of activities:

- Assessment weight: Activities with a higher assessment weight may be considered a priority. For example, in the case of S382 (Astrophysics), the group project's write-up contributes to 35% of the Overall Examinable Score (OES), making it a significant component.

- Complexity and difficulty: More complex activities, especially those involving group work or experiments, may be prioritized. Module chairs express a need for real-time support in activities where students work in pairs or groups, as issues in these scenarios could have a more significant impact.

- New or unfamiliar activities: New modules or activities that are being introduced for the first time may be prioritized. Module chairs, such as for the module SM381 (Electromagnetism), express a desire for real-time support in the first run of a new OSL experiment to address unforeseen challenges.

- Accessibility and special requirements: Activities that involve accessibility challenges or special requirements for students, such as those with disabilities or anxiety, are mentioned as priorities for real-time support.

- Real-time experiments with limited slots: Activities where students perform genuine remote experiments in booked slots are considered priorities.

- Time constraints: Activities with short completion time windows or that are expected to be completed quickly may be considered a priority for real-time support. In T193 (Engineering: Frameworks, Analysis, Production), real-time support is valuable for complex activities at the 2nd or 3rd level, where uncertainties may arise in setting up experiments or interpreting output data. This is especially crucial for activities integral to assessments, which are expected to be completed in a short time window.

- Feedback and experience: The feedback received from students and tutors after the initial run of an activity can influence the decision to prioritize real-time support. In S290 (Investigating Human Health and Disease), general

feedback indicates that while the tools used in the module are appreciated, some, notably for the ELISA experiment, are perceived as complex by students.

It's important to note that the prioritization of activities for real-time support can vary across modules, and module chairs may consider a combination of these factors to determine the most critical activities for immediate assistance.

5.1 Selection of activities for real-time support

One such activity chosen for emphasis is T229 (Mechanical engineering: heat and flow), OEL 2.3: Characterizing a wing section (scale 4). Currently, students in this activity can raise queries in the student forum, which are addressed by the forum moderator, the module team, or through direct contact with tutors. Support is provided by both the module team members and Associate Lecturers (ALs), with the forum moderator playing a key role. The introduction of real-time support for this activity would prove especially beneficial for students facing accessibility challenges and those finding it challenging to work effectively in teams. This OEL is conducted in pairs, followed by a group discussion in groups of 3 or 4. Additionally, there is at least one question related to this activity in the assessment TMA02.

To ensure the success of this activity, key factors to focus on include evaluating communication effectiveness within pairs and groups, assessing the allocation of tasks, understanding completion rates and the quality of group discussions, analyzing performance in TMA02, and gauging the engagement and resolution efficiency in the student forum. If real-time support is introduced, careful attention should be paid to the response time for addressing queries, particularly for students with accessibility challenges. This comprehensive evaluation approach aims to enhance the overall learning experience and outcomes for students participating in T229.

5.2 Pilot trial

The pilot trial introduced an Adobe Connect online room, which was hosted on the Virtual Learning Environment (VLE) of the T229 module, specifically on the Mechanical Engineering: Heat and Flow website, as part of the experiment OEL 2.3: Characterizing a Wing Section. This room, named "OSL Pilot Live Support," was established by Learner and Discovery Services (LDS) Online Services and served as a hub for live support sessions conducted by tutors. Fig. 1 and Fig. 2 show the Adobe Connect view during live support sessions for tutors and students, respectively. Throughout the pilot trial, tutors shared the room link with students, a process facilitated by student slot bookings through OSL. The room featured tailored functionalities, such as live chat, with a simplified interface for students, granting them access to interactive discussions. Students had the ability to communicate via chat and voice. In contrast, tutors were equipped with enhanced privileges, including admitting students into the room, arranging students into groups or individual breakout sessions,

and facilitating screen-sharing capabilities. The room was designed with specific features, such as live chat, but without the need for recording. It included an end-of-session poll, and tutors had the option to grant screen-sharing permission to students using a secure procedure. Overall, the pilot trial would successfully enhance the learning experience in T229 and other modules by providing a dedicated online space for interactive support and collaboration between tutors and students.

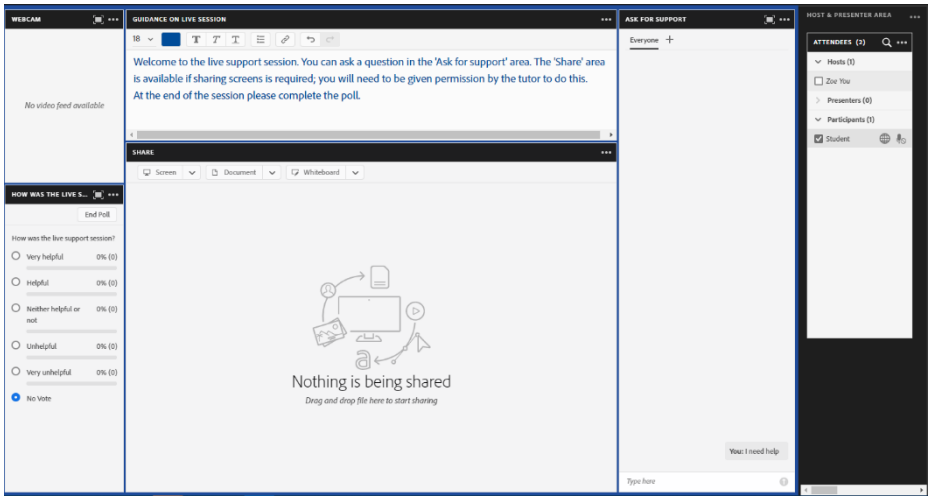

Fig. 1. Tutors' Adobe Connect view during live support sessions.

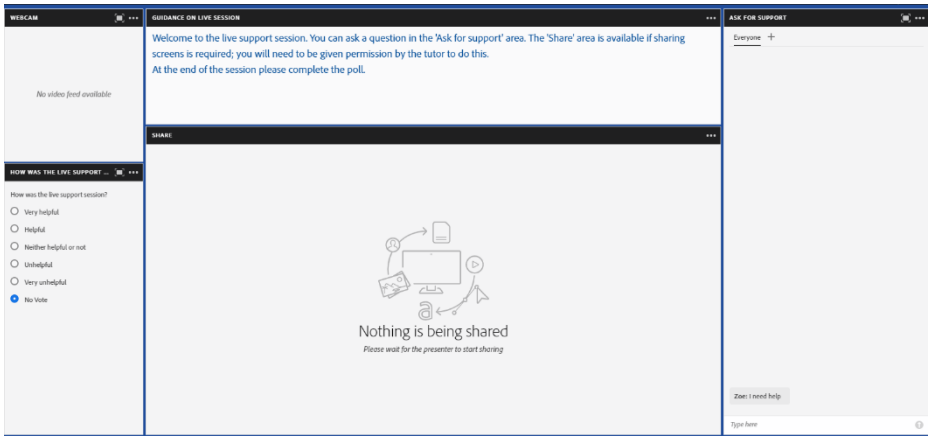

Fig. 2. Students' Adobe Connect view during live support sessions.

5.3 Cognitive load theory considerations in the experiment

The design and implementation of the live support sessions in the pilot trial of OEL 2.3: Characterizing a Wing Section in T229 were underpinned by key principles of

Cognitive Load Theory. CLT posits that effective learning occurs when the cognitive load imposed on learners aligns with their cognitive capacities. In the context of our experiment, several aspects were considered to optimize the cognitive load for both students and tutors.

- Simplified student interface: To reduce extraneous cognitive load on students, the Adobe Connect interface for students was intentionally streamlined. They were provided with straightforward access to essential features such as live chat and voice communication, focusing on ease of use and minimizing unnecessary complexity.

- Enhanced tutor privileges: Recognizing the role of tutors as facilitators, the interface for tutors included advanced features and privileges. This aligns with CLT by distributing the cognitive load appropriately — tutors were equipped with the ability to admit students, organize breakout sessions, and manage screen-sharing permissions, facilitating a more interactive and dynamic learning environment.

- Clear communication channels: Effective communication is vital in managing cognitive load. Both tutors and students had designated channels for communication, ensuring a focused and purposeful exchange of information. Live chat and voice communication features contributed to seamless interactions without overwhelming cognitive resources.

- End-of-session poll for feedback: CLT emphasizes the importance of feedback in the learning process. The inclusion of an end-of-session poll in the Adobe Connect room allowed for the collection of valuable feedback. This iterative feedback loop is aligned with CLT principles, promoting continuous improvement in the learning experience.

By consciously incorporating these considerations informed by Cognitive Load Theory, the experiment aimed to create an environment conducive to optimal learning, ensuring that the cognitive load imposed on participants was balanced and supportive of the learning objectives. This explicit reflection on CLT principles underscores the pedagogical foundations guiding the design and execution of the live support sessions.

5.4 Pilot T229 live support sessions feedback

The pilot T229 live support sessions aimed to assist students in resolving technical issues during experiments. Seven support sessions were offered by two tutors. However, despite students booking slots for experiments, only one student attended a live support session. The reasons behind the low attendance remain unclear as students did not fill out the survey. Tutor feedback indicated that students might not have needed extensive live support because they managed to conduct experiments independently. Positive feedback in the forum chat suggested that students found the recorded video

helpful. Tutors recommended providing support, especially during the first experiment when most issues were encountered. Tutors recorded a video of the experiment and suggested using this approach to provide support in the module. However, they noted that being "on-demand" to answer questions was demanding on their time, especially when no students turned up. Tutors suggested gathering students' suggestions on what would help them in the experiment and offering tailored support accordingly. Both tutors recommended scheduling live support during sessions when many students were booked to maximize its effectiveness.

In the next phase of the project, we will explore several key initiatives. Firstly, we will consider the implementation of live support sessions during the initial wind tunnel experiment in T229, capitalizing on the potential benefits of providing immediate assistance to students. Additionally, we aim to further investigate the feasibility of utilizing pop-up messages as a means to offer support during sessions with multiple bookings, ensuring that students receive the help they require when they need it most. Moreover, we will assess the viability of extending the pilot live support sessions to other modules, including S382, SXPS288, and S290, where experiments may also derive significant advantages from real-time assistance.

6 Implementing an effective live support system

Implementing an effective live support system within the Open STEM Labs at the Open University involves several crucial aspects that need careful consideration:

- The choice of the platform for live support sessions is a fundamental step. Adobe Connect has been selected due to its suitability for real-time communication, screen sharing, and text chat features. However, it is essential to remain open to exploring other instant messaging platforms to meet changing needs. Integrating the chosen platform into the Open STEM Labs interface is key for a seamless student experience.

- Assigning qualified staff members to provide live support during scheduled sessions is critical. These staff members may include tutors, project specialists, PhD students, or lab technicians. Proper training and guidance should be provided to ensure they can effectively assist students.

- Creating a clear and accessible schedule for live support sessions is essential. This schedule should be readily available to students to manage their expectations and participation. Additionally, promoting these sessions through module websites, forums, and the OSL booking page is crucial for ensuring students are aware of the support available.

- Preparing necessary resources, such as slides, videos, and demonstrations, in advance of live support sessions enhances the overall learning experience. These resources should be easily shareable with students during sessions.

- Collecting feedback from students after each live support session is vital for continuous improvement. Identifying areas that require enhancement and ensuring students are receiving the assistance they need is an ongoing process.

By addressing these aspects thoughtfully, the Open University can create an effective live support system that enhances the educational experience for students in the Open STEM Labs.

7 Conclusion

In this paper, we discussed the process of implementing a robust and effective live support system within the Open STEM Labs (OSL) at the Open University. Our exploration began with a reflection on the specifications necessary to provide live support sessions, encompassing platform selection, session scheduling, staff assignment, and effective advertising. Recognizing the importance of a user-friendly interface, we also explored functional and technical requirements, including real-time communication, chat functionality, screen sharing, and notifications, while considering compatibility, security, scalability, and accessibility.

The quest to enhance student engagement and satisfaction through live support led us to ponder how to assess its effectiveness. Strategies such as post-session surveys, performance analysis, and monitoring student engagement have emerged as valuable tools in evaluating the impact of live support on learning outcomes and satisfaction.

To implement an effective live support system within the Open STEM Labs at the Open University, we have identified the technical and functional requirements necessary for its success. These requirements form the backbone of a system that promises to enhance the educational experience for our students. Moreover, we investigated the incorporation of a request button for students during OSL activities, emphasizing its functional and technical requisites, integration within the OSL interface, and adherence to accessibility standards. As we look to the future, we are committed to translating these requirements into action. A prototype is currently in development, with plans for rigorous testing in 2024. This iterative approach allows us to refine and tailor the live support system to the specific needs and expectations of our students, ensuring that it not only meets but exceeds their educational support requirements.

To conclude this paper, it is evident that the successful implementation of a live support system requires meticulous planning, adherence to requirements, and a commitment to enhancing the student experience. By weaving these threads together, we lay the foundation for a dynamic, responsive, and effective live support ecosystem within the Open STEM Labs, fostering enhanced learning and facilitating student success. This journey is ongoing, offering opportunities for innovation and continuous improvement. Through this endeavor, we provide a seamless and accessible support system that empowers our students to excel in their STEM studies and reach their academic goals. With continuous improvement at the forefront of our efforts, we are

confident that the live support system will play a pivotal role in enriching the learning journey of all those who engage with it.

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Appendix

OpenSTEM Labs 'Lab-Assist' Project: Survey to Module presentation chairs

Feedback from students using the OpenSTEM Labs (OSL) has identified an opportunity to enrich the student experience through tailored real-time support while working in remote teaching labs.
The purpose of the two-year funded project 'Lab-Assist' is to investigate how enhanced real-time support could be provided to students conducting OpenSTEM Labs activities. Currently, support occurs by a number of mechanisms that are often asynchronous and vary across areas of OSL activities.
The concept behind the Lab Assist project is to provide real-time or near-real-time support to students who are having difficulty completing OSL experiments. The project is intended to particularly benefit students with disabilities who may find it more difficult to participate in practical activities without support, and also those with additional needs that are a barrier to participation. The project could contribute to reducing the attainment gap for disadvantaged students. Although the focus is intended to be on students with additional needs, there is potential for broader applicability, depending on what solutions are developed.

If you require any further information, please do not hesitate to contact Dhouha Kbaier who is the lead academic of this project.
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It is greatly appreciated that you take the time to complete this survey. The opinions you provide are valuable and will be considered as one of the first steps in our research and data gathering exercise, in preparation for subsequent trials of one or more support tools.

1. Your name:
2. Which module(s) are you chairing?
3. Please complete the following table. Please copy and paste the table if you are chairing more than one module.

Module Title/ code:
How many OSL activities are included in the module?

Activity Name			
What type of support is already available for this activity (if any)?			
Who is providing the support for this activity (E.g., Associate Lecturers, Module Team members)?			
Is the OSL activity included in the module's assessment?			
Is the activity likely to benefit from (near) real-time support?			

Please rate the activity on a scale of 1 to 5 (5 would definitely benefit from real-time support).			
Comments/suggestions			

4. What are the current metrics you use to measure the success of these OSL activities? If students can complete some specific activities very well without issues, we may prioritise some other activities for the live support.
5. Would you like to share any feedback that you have received from students or tutors regarding the need for additional support in OSL activities?
6. In your opinion, which kinds of activities would benefit most from real-time support, for example in a timetabled session with live support via chat or video conference? Could you please explain why this is important?
7. If real-time support were available, who would benefit and what would be the benefits?
8. How do you think this support could be best implemented? Select one of more of the following options. Do not hesitate to add your suggestions and comments on how a combination of these would be most effective.

☐Live chat

☐Adobe Connect Video conference

☐Email

☐Telephone

☐Peer support (students running the experiment at the same time)

☐Group support (staff member providing support to a group of students conducting the experiment simultaneously)

☐Pop up message offering live support

☐Special time slots in the booking system for supported sessions

☐Separate booking system with special sessions

9. If there were a need to prioritise students who should have access to real-time support, which students should be prioritised, and how could this be done?
10. Would you be interested in participating in a future trial of real-time or near-real time support on your module?
11. Any other information:

Thank you