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On the Use of an Online Polling Platform for Enhancing Student Engagement in an Engineering Module

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Abstract: Students' engagement is a fundamental challenge in large classrooms in higher education. In recent years, innovative technologies such as electronic learning and online polling platforms have made learning more engaging, effective, and interactive. By using these platforms, educators can create more inclusive and enriching learning environments. This paper presents a novel approach in which an online technology is employed to enhance students' learning experience. In this approach, features of an online polling platform, i.e., Slido, are employed to enhance students' engagement in an engineering module, i.e., 'Mechanics of Solids', which is recognised as a fundamentally challenging module with difficult subjects. This study investigates how the interactive features of such technologies, such as real-time polls, question and answer (Q&A) sessions, and quizzes, can provide a more active and practical learning environment by improving student engagement in the classroom. In total, six online polls were designed: one for ice-breaking, two on the topics of shear forces and bending moment, two on stresses, and one on deflection. Each poll was presented to the students, and they participated in them by scanning a QR code or typing the poll's code online. The rate of students' participation in polls is extensively discussed to show the effectiveness of the proposed method. The findings of this study show a significant increase in student participation in classroom activities compared to traditional methods. Student feedback also indicates a positive learning experience with the use of the proposed approach. It is shown that the proposed approach has the potential to transform the way engineering students engage with challenging subjects, leading to enhanced learning outcomes and a more positive learning experience.

Keywords: Slido; interactive teaching and learning; civil engineering; lesson planning

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1. Introduction

Learning is an iterative and continuous process that never truly ends. It starts with reading and analysing information, progresses through practical applications, and is followed by the expansion of knowledge in a consistent manner. Traditional learning is restricted by time limitations and location boundaries in a classroom with limited student participation. The learning process is traditionally characterised by a one-way transmission of knowledge from lecturers, while students are passive receivers [1]. Hence, it is crucial to make a significant change in educational practices. Therefore, in the context of teaching and learning pedagogy, the emergence of digital tools has revolutionized traditional learning methods to enhance the learning process and elevate learning outcomes [2]. Learning by using these digital tools is referred to as electronic learning (e-learning) or online learning, which has transformed the learning environment. The landscape of education has developed significantly with the integration of e-learning and digital tools [3].

In recent years, online learning has attracted much attention in higher education, particularly within the discipline of engineering. This trend aligns with the broader adoption of online learning across various academic fields. For example, during the COVID-19 pandemic and the lockdown that followed, online education became popular in universities, colleges, and schools across the world and allowed students to use their time effectively [4]. In addition, online polling platforms have emerged as a valuable asset, enabling lecturers to engage their students and gather real-time feedback. The importance of student engagement lies in active learning [5], collaboration [6], communication [7], retention [8], and motivation [9]. Active learning shows how students' engagement is crucial to growing critical thinking [10] and problem-solving skills [11]. Retention and motivation explore how engaged students are more likely to stay committed, motivated, and enthusiastic about their studies. Collaboration and communication indicate how student engagement facilitates collaboration and communication among colleagues, enabling the exchange of ideas and raising a rich learning environment.

A student who is fully engaged is one who is involved in the learning process, motivated to learn, and actively participates. Engaged students are vital to a healthy classroom environment. When students are invested in the learning process, they are more likely to retain information and succeed. Increased engagement can also lead to better classroom discussion, collaboration, and overall satisfaction with the module. According to the literature, most studies exploring student engagement have focused on face-to-face learning environments, and there is a research gap regarding the impact of online polling platforms on students' engagement, particularly in engineering disciplines. For example, sometimes, students are present in the classroom but not actively engaged in the learning process [12]. There are some possible explanations for this. For example, students may be struggling to understand the material and may feel discouraged from participating [13]. They may also be afraid of asking questions or making mistakes, particularly in large classes [14,15]. In addition, students may be distracted by their phones, laptops, or other devices [16]. This can make it difficult for them to focus on the class material and participate in discussions or activities. Students may be daydreaming or thinking about something else [17]. This can also make it difficult for them to follow along and engage in the learning process. Finally, students may not be interested in the material or may not find the class engaging [18]. This can result in them being less likely to participate actively in the learning process.

According to Driscoll [19], learning is defined as "a persisting change in human performance which must come about as a result of the learner's experience and interaction with the world". This definition includes the emotional, mental, and physiological aspects of the three major learning theories, i.e., constructivism, cognitivism, and behaviourism, which generate the foundation of instructional environments. While these theories provide valuable insights into the learning process, they were developed during an era when learning was not impacted by technology [3].

E-learning refers to the process of acquiring knowledge or skills through digital platforms, typically over the Internet. E-learning has brought about a paradigm shift in education, offering a wide range of benefits that have transformed traditional teaching methods. This includes flexibility in learning schedules, access to diverse educational resources, engaging learning experiences, personalized learning paths, cost-effectiveness, global reach and connectivity, real-time feedback and assessment, and continuous skill development. Online polling platforms utilize innovative technologies to facilitate interactive learning experiences. Educators can create polls, quizzes, and surveys, while students can participate and provide responses in real time. The platform then generates comprehensive reports, allowing educators to analyse the data and gain valuable insights into student performance and comprehension. The following features of a good online polling platform can be named:

- User-Friendly Interface: An intuitive and easy-to-use interface ensures that both educators and students can navigate the online polling platform effortlessly [20,21].
- Real-Time Response Tracking: The ability to track and analyse responses in real time helps educators identify knowledge gaps and adjust their teaching strategies accordingly [22,23].

- Interactive Question Types: An online polling platform should offer a range of question types, including multiple-choice, open-ended, drag-and-drop, fill-in-the-blank, and image-based questions, to adapt to diverse learning needs [24–26].

Educators can stimulate audience interaction with questions requiring a raised hand or thumbs-up/thumbs-down to reflect agreement/disagreement or use an interactive polling software such as Slido (sli.do), Mentimeter (mentimeter.com), or Poll Everywhere (polleverywhere.com) [27]. In addition to these tools, several other platforms, such as Kahoot, Slides With Friends, and AhaSlides, provide interactive features. Mentimeter can be considered a dated platform with limited features, as it is difficult or sometimes impossible to edit its slide interface. Kahoot is costly with a complicated user interface and a lack of customisation. The response time (delay) could be improved in AhaSlides. Slido works well for large groups of up to 5000 participants compared to Poll Everywhere's limit of 700. Both Poll Everywhere and Slido share features such as anonymous polling options and integration with many different types of presentation software. However, Poll Everywhere focuses more on assessment and live feedback, while Slido emphasizes interactive conferences and Q&As. Therefore, in this study, Slido was selected as the main platform.

As technology advances, e-learning is prepared to play an even more significant role in shaping the future of education and training. The following is an overview of the applications of e-learning:

1. K-12 (kindergarten through 12th grade) education: E-learning has become an integral part of K-12 education, providing students with flexible and personalized learning experiences. Online courses, interactive modules, and virtual classrooms cater to diverse learning styles and paces, catering to students of all abilities and backgrounds. E-learning also expands access to quality education, particularly in remote areas or for students with unique learning needs [28,29].
2. Higher education: E-learning has transformed higher education, offering a wider range of courses, specializations, and degrees. Online degree programs provide students with the flexibility and convenience to pursue their education without geographical constraints. E-learning also enables students to balance their studies with work or family commitments, promoting lifelong learning opportunities [30–32].
3. Professional development and training: E-learning has become a valuable tool for professional development and training, providing employees with upskilling and reskilling opportunities. Online courses, webinars, and simulations offer cost-effective and convenient ways to enhance skills and knowledge, contributing to employee growth and organizational success [33,34].
4. Corporate training and employee engagement: E-learning has gained significant traction in corporate training, providing companies with a versatile platform to deliver training programs to their employees. Online modules, interactive simulations, and personalized learning paths cater to diverse skill levels and job roles, enhancing employee productivity and engagement [35–37].
5. Lifelong learning and self-education: E-learning has democratized learning, making it accessible to anyone seeking knowledge and personal development. Online courses, tutorials, and educational resources cater to a wide range of interests, from language learning and technical skills to creative pursuits and personal growth [38–40].
6. Distance learning and remote collaboration: E-learning has facilitated distance learning and remote collaboration, enabling people to connect and learn from experts worldwide. Online seminars, workshops, and collaborative projects foster knowledge exchange and professional development among geographically dispersed individuals [41,42].
7. Healthcare education and patient education: E-learning has revolutionized healthcare education, providing medical professionals with access to continuous learning opportunities. Online courses, simulations, and case studies enhance the knowledge and skills of doctors, nurses, and other healthcare providers. Additionally, e-learning

platforms offer patient education resources, empowering individuals to manage their health and make informed decisions [43–45].

8. Non-profit and social impact initiatives: E-learning has been instrumental in supporting non-profit organizations and social impact initiatives. Online courses, webinars, and training modules provide communities with access to education and skill development, promoting literacy, entrepreneurship, and sustainable practices [46,47].
9. Military training and specialized skill acquisition: E-learning has become an integral part of military training programs, providing soldiers with access to specialized skills and knowledge. Online simulations, virtual environments, and adaptive learning platforms enhance combat readiness and equip soldiers with the skills to operate complex equipment and perform critical missions [48,49].

In recent years, several studies have been carried out on online learning in higher education. For example, the authors of [18] conducted a field experiment to investigate the impact of peer information interventions on learning engagement and outcomes in an online learning setting without external incentives. Their findings revealed nuanced effects and practical implications for instructional design. Another study by Ku, Tseng, and Akarasriworn [6] was developed to examine online courses with collaborative learning components among 197 graduate students across three consecutive academic years. They investigated the relationship between online collaboration factors and teamwork satisfaction through surveys and open-ended questions. They also extended prior research by collecting a larger sample size to explore students' attitudes toward online collaborative learning experiences. Their study demonstrated that online collaboration factors significantly influenced teamwork satisfaction among graduate students in online courses, highlighting the importance of several factors, such as team dynamics and acquaintance and instructor support, for successful collaborative learning experiences.

The authors of [9] detailed an implementation of a technology-supported learning environment to promote in-class participation, collaborative learning, and increased student motivation. Their research indicated the effectiveness of such an environment in enhancing participation, motivation, and collaborative learning, which led to improved teaching quality and increased student engagement. In another report by Thakur et al. [50], a comprehensive analysis of approximately 50,000 tweets related to online learning during COVID-19 was conducted to analyse sentiment trends, subjectivity levels, toxicity categories, gender-specific tweeting patterns, and the average activity of users.

Lakka et al. [4] designed a virtual reality laboratory exercise in a physics course to familiarize students with basic methods of statistical analysis. They evaluated the effectiveness of the methodology through questionnaires and assessments administered to two groups of second-year students. They proved that virtual reality laboratories can extensively improve student performance, satisfaction, and confidence in conducting experiments independently, particularly in distance education programmes.

As another example, various tools and resources of information and communication technologies (ICTs) (Mentimeter, Slido, Poll Everywhere, Kahoot, etc.) were presented and discussed by Sampath et al. [51] to support effective online teaching and learning. It was concluded that ICT tools could effectively be used for online learning due to their user-friendliness and potential to enhance student engagement and learning outcomes. Stojaković [52] also explored the potential of increasing student engagement through the use of Information Technology (IT) solutions, such as Slido, in an online teaching environment. It was shown that features of such technology could lead to higher student engagement rates by encouraging quiet students to ask questions anonymously, collecting feedback for the continuous improvement of teaching, and providing real-time understanding checks.

Hence, it is required to better understand how the interactive features of online polling platforms, such as real-time polls, quizzes, and Q&A sessions, can provide a more active and involved teaching–learning environment by improving student engagement in the classroom. To address this, this study investigates whether using an online polling platform can enhance student engagement in an engineering module compared to traditional teaching methods (the main research question). Therefore, in this paper, the use of an online polling platform named Slido is studied to explore student engagement in a second-year Civil Engineering module at University College Dublin. The module is called "Mechanics of Solids—CVEN20010/MEEN20040". A total of 217 students (37 from Civil Engineering and 180 from Mechanical Engineering) were registered for this module in the spring of 2024. The module contains lectures, assignments, and tutorials, and the students were evaluated using continuous assessments (27%) and a final exam (73%). This work investigates the part of the module that covers shear forces, bending moments, stresses, and deflections. The implementation of the online platform in this module is evaluated through a quantitative and qualitative approach. The hypothesis is that the use of online polling will significantly improve their engagement. The quantitative analysis involves tracking student participation in the polls, as well as measuring the overall class attendance. The qualitative analysis focuses on student engagement and feedback.

2. Methodology and Results

In this study, a module called "Mechanics of Solids—CVEN20010/MEEN20040" is selected as the case study due to its challenging nature as a theory-intensive module with heavy fundamental topics for engineering students. The module was delivered in the spring of 2024 at University College Dublin in Ireland. This module focuses on the interactions between and responses of solid bodies subjected to externally applied loads. Methods for determining the internal forces in simple structural systems are developed in addition to procedures for quantifying the demand, in terms of induced stresses, on structural materials. As can be seen from Figure 1, four settings are planned considering the complexity of the module over time.

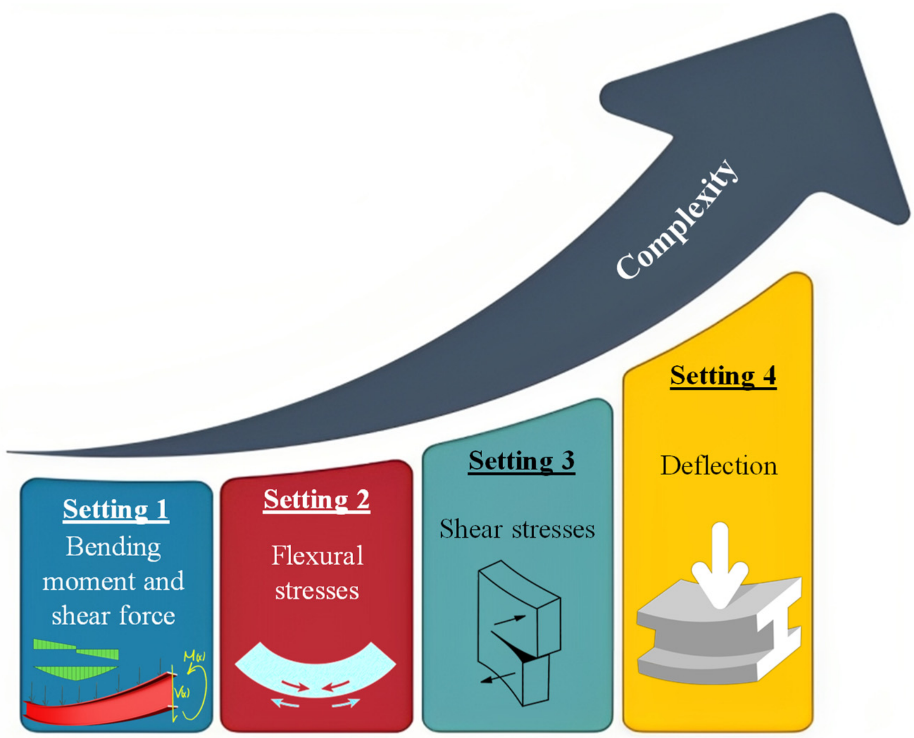


Figure 1. Sessions embedded in the online platform were designed, including 6 technical sessions and 1 feedback session.

For each session, the designed questions were shown to the students on the screen in the form of multiple choices or polls. In most cases, the students had the opportunity to track the number of votes for the potential answers in real time, and in some cases, they had the opportunity to correct their answers. The students mostly used their smartphones to enter the platform, either using a code or a QR code shown on the screen. Figure 2 shows a schematic of the approach used in this paper.

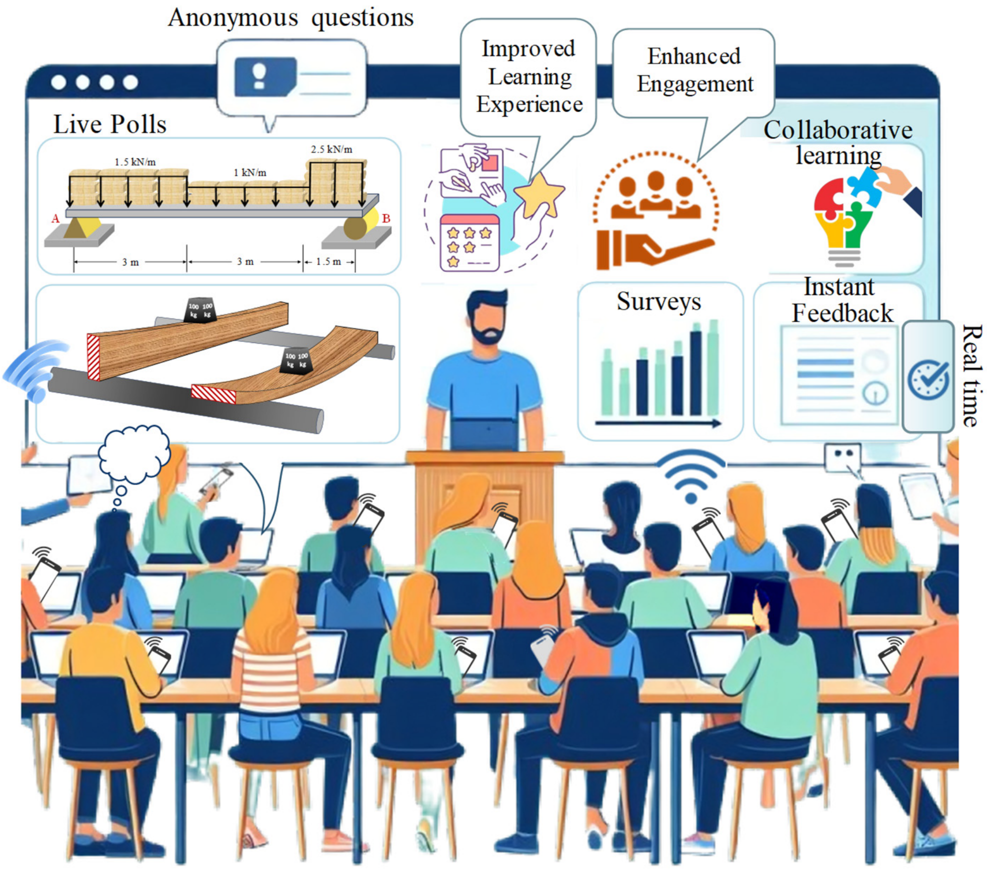


Figure 2. A schematic of the proposed method.

2.1. Ice-Breaking Poll (Poll 1)

One of the main challenges that engineering lecturers need to deal with when it comes to large lectures is breaking the ice with students. This means providing a relaxed environment for the students, who feel comfortable connecting with the facilitator without any barriers. For this purpose, the first sets of online questions were mostly introductory and ice-breaking questions to create a welcoming and engaging atmosphere for the students and to determine their initial level of understanding of the module material (see Table 1). These questions also aim to motivate the students and set the stage for the subsequent questioning sessions. The first question encourages the students to test the platform with a non-technical question. As the students are from two disciplines, Mechanical and Civil Engineering, the second ice-breaking question was also set to create a constructive competition to improve their engagement. The third question challenges the students' expectations from this module. It is designed to allow the students to ensure that they know the learning outcomes of the module. In addition, the fourth question gives the students a chance to compare the mechanics of solids with other types of mechanics, e.g., mechanics of fluids, and to understand the differences. Finally, the last question ensures that the students are familiar with different types of mechanical and civil structures under bending.

Table 1. Ice-breaking questions.

Poll Description	Questions
Introduction	(a) From 1 to 5, what is your energy level today?
	(b) Civil or Mechanical?
	(c) What do you hope to learn from this course? • To learn how to design structures • To learn how to find the internal loads • To learn how to find stresses • To learn how to find the internal loads and stresses
	(d) What are the types of mechanics in terms of matter?
	(e) Name a few examples of beams under bending! (See Figure 3)

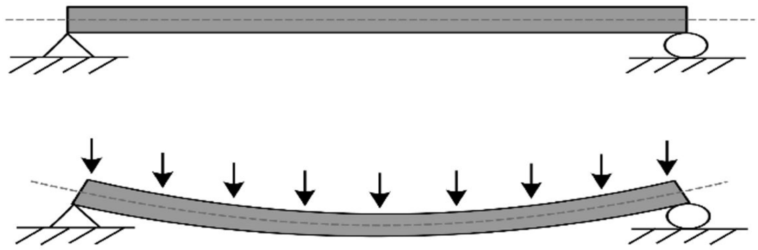


Figure 3. Name a few examples of beams under bending!

The students' feedback is presented in Figure 4a–e. From the analytics recorded in the online platform, 155 students logged into this poll, and 124 voted for at least one of the questions. However, in traditional approaches, it was challenging to find even a few students participating in discussions such as these. As can be seen in Figure 4a, the students express that the level of their energy is about 3/5. This is also an important point, as this part of the module started at week 7 of a 12-week semester. Therefore, it is normal to see that the students may not be able to attend the lectures with full energy, which may create an extra challenge in engaging them. As expected, it can be seen in Figure 4b that there was a larger number of Mechanical Engineering students compared to Civil Engineering students. Figure 4 shows that a good portion of the students have a good understanding of the module learning outcomes, but a large percentage struggle in identifying differences between choice 1 (to learn how to design structures) and choice 5 (to learn how to find internal loads and stresses). However, the options were carefully selected to ensure that the students understood the role of finding internal loads in the process of designing a structure. However, they should also understand that this module is not about the design of structures.

2.2. Polls on Shear Forces and Bending Moments (Polls 2 and 3)

The first section of this part of the module was about plotting shear force and bending moment diagrams, particularly for beams under bending. At the end of this section, students need to learn how to plot these diagrams manually. However, the students first need to learn about different types of external loads that can be applied to beams, such as a point load or a uniformly distributed load (UDL). In addition, they should be able to calculate the reaction forces at the support and be familiar with different types of supports, such as pinned, roller, or fixed supports. For this purpose, the second poll was designed with the questions listed in Table 2. These polls were implemented in week 7 of the semester. The first question is designed to ensure that the students know the difference between a simply supported beam and a cantilever beam. The second question challenges the students to understand the differences between external and internal forces, and the third question shows an example of a UDL. The fourth question is designed as a very simple exercise for the students to practice basic tasks such as calculating reaction forces in beams under bending. Question number 5 is a more complicated version of the previous question.

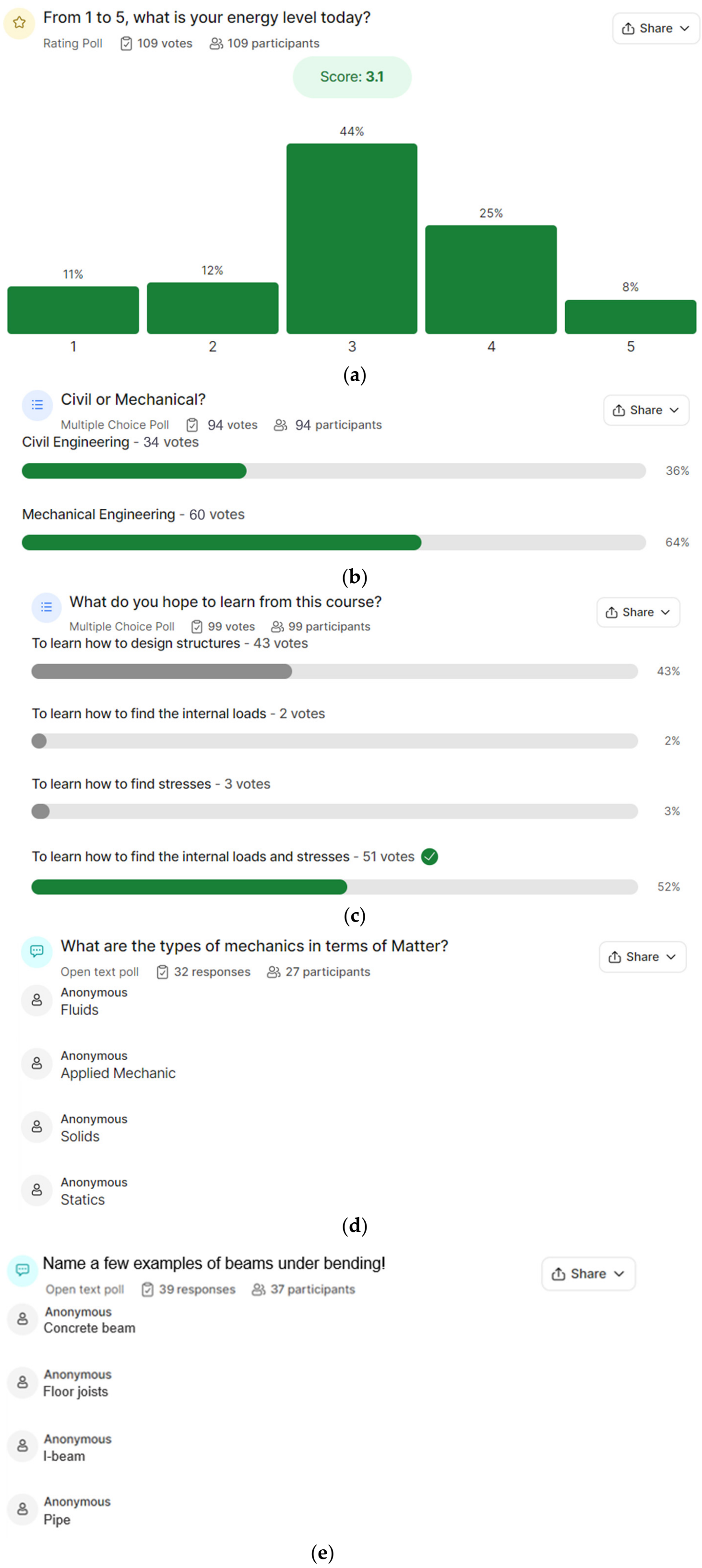


Figure 4. Interactive feedback for poll 1.

Table 2. Shear force and bending moment questions.

Poll Description	Questions
Shear Force and Bending Moment	(a) What type of beam is a diving board? (See Figure 5) ☐Simply supported ☐Cantilever
	(b) What is the external force on the board? (see Figure 5) ☐The weight of the diver ☐The reaction at the support ☐Both
	(c) Is this a case of a point load or uniformly distributed load? (See Figure 6) ☐Point load ☐UDL
	(d) What is the reaction force at point A? (See Figure 7) ☐10 ☐20 ☐25 ☐30
	(e) What is the reaction force at point B? (See Figure 8) ☐6.25 ☐18.75 ☐12.25 ☐22.5
	(f) Is this simply supported beam in equilibrium with external loads? (See Figure 9) ☐Yes ☐No
	(g) If we only consider 1/4 of the beam, is this part in equilibrium in terms of forces? (See Figure 10) ☐Yes ☐No
	(h) How about equilibrium in terms of moments? (See Figure 11) ☐In equilibrium ☐Not in equilibrium
	(i) Is the quarter beam fully in equilibrium now? (See Figure 12) ☐Yes ☐No
	(j) What are the values for V and M? (See Figure 13) ☐V = F/2, M = FL/2 ☐V = F/2, M = FL/8 ☐V = F/4, M = FL/2 ☐V = F/4, M = FL/8

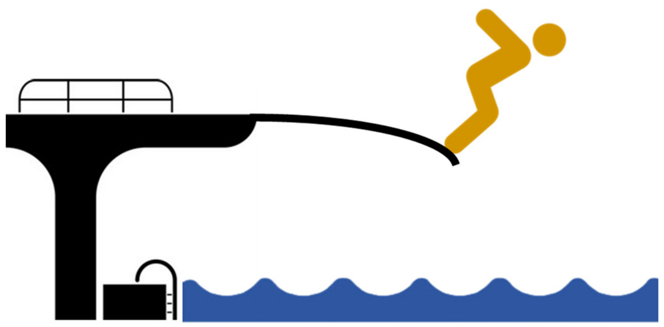


Figure 5. What type of beam is a diving board, and what is the external force on the board?

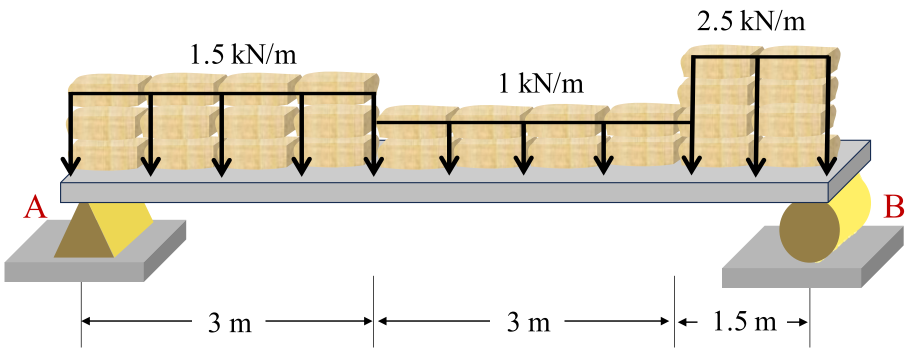


Figure 6. Is this a point load or uniformly distributed load?

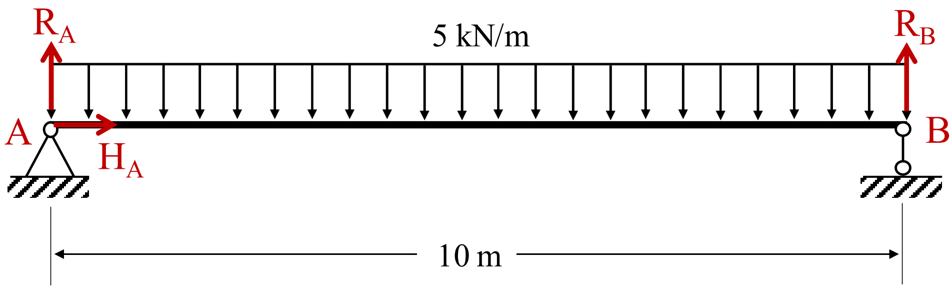


Figure 7. What is the reaction force at point A?

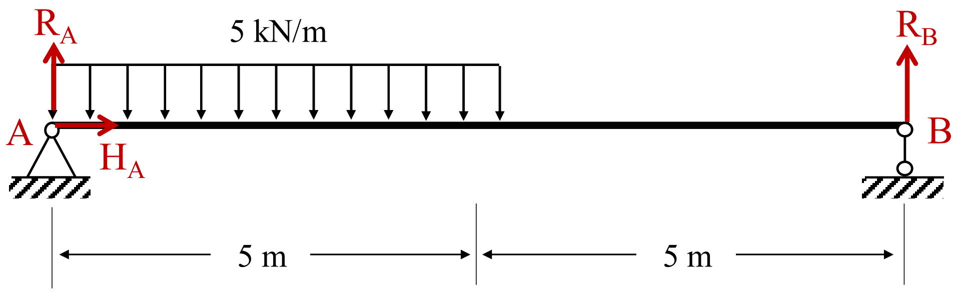


Figure 8. What is the reaction force at point B?

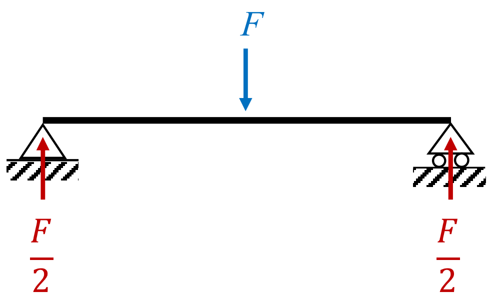


Figure 9. Is this simply supported beam in equilibrium with external loads?

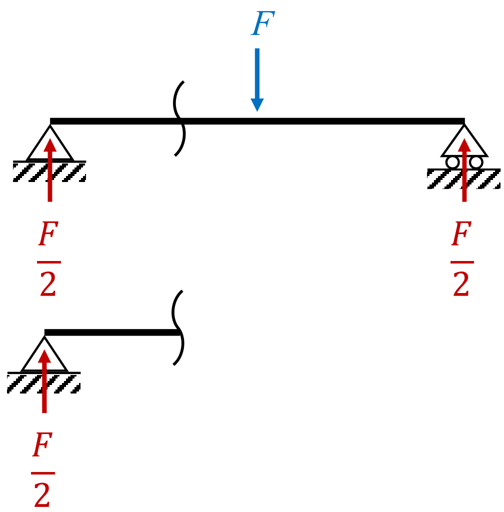


Figure 10. If we only consider 1/4 of the beam, is this part in equilibrium in terms of forces?

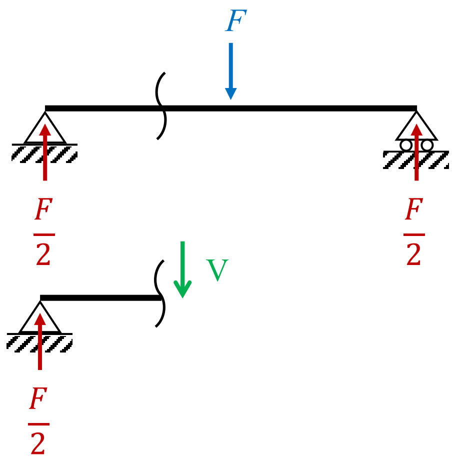


Figure 11. How about equilibrium in terms of moments?

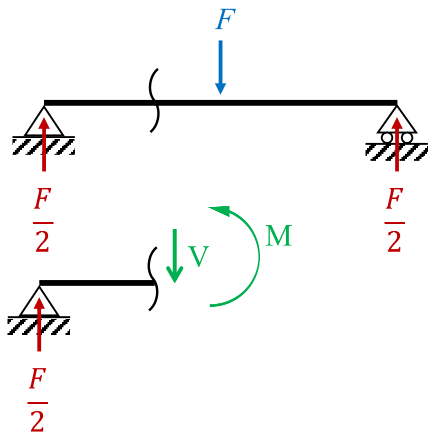


Figure 12. Is the quarter beam fully in equilibrium now?

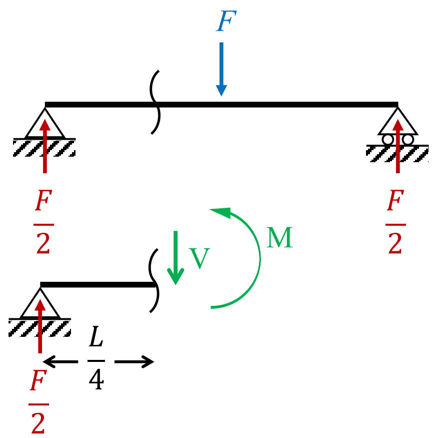


Figure 13. What are the values for V and M?

Questions 6–10 explain the concept of internal forces step by step. Figure 9, as part of Question 6, shows a beam that is in equilibrium considering all of the external forces. In the next question, ¼ of the beam is shown (Figure 10), and the students are asked if this portion of the beam is in equilibrium or not. Figures 11 and 12 show the same beam, while a shear force and bending moment are added step by step. Finally, in Figure 13, the students are asked to find the shear force and bending moment for this case.

Two polls were considered for this part. The online platform data show that 119 and 81 students logged into polls 2 and 3, respectively. A total of 104 and 69 students actively participated (voted at least for one question), representing approximately 87% and 85% of the logged-in students. The students' feedback is shown in Figure 14a–e.

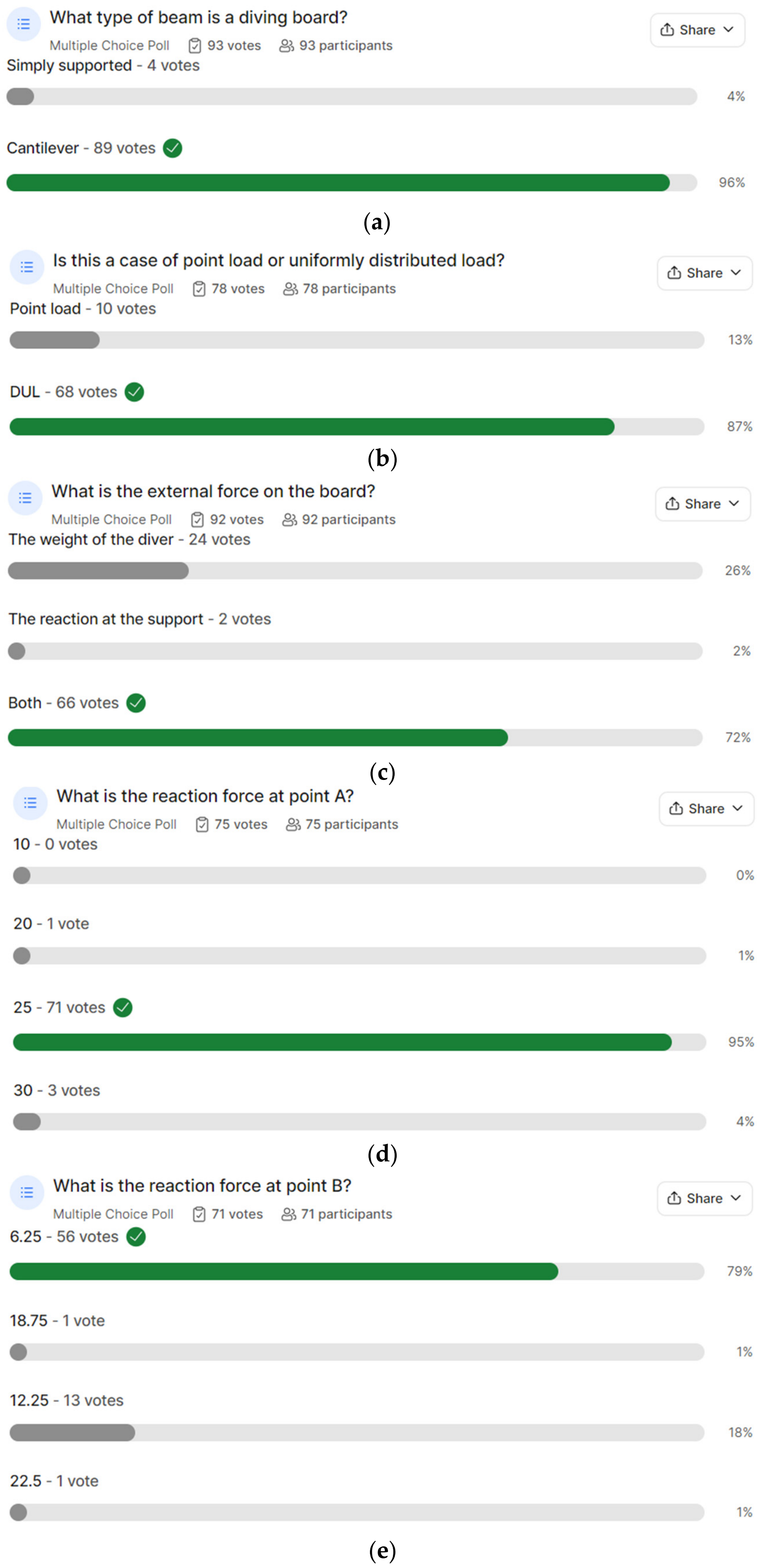
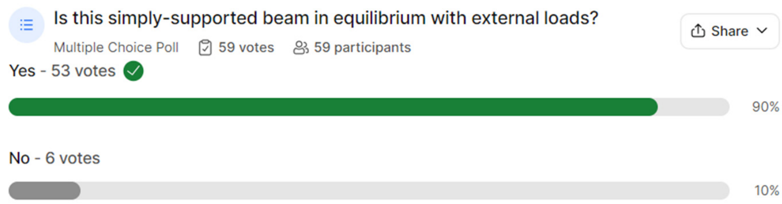


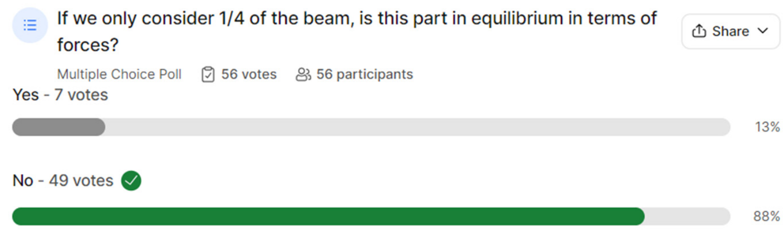
Figure 14. Interactive feedback for poll 2.

Figure 14a,b show that most of the students are familiar with the types of beams, and they know the concepts of a point load and UDL. Figure 14c shows that the students know that the forces applied to the structure and the reaction forces should both be considered as external forces. Figure 14d,e also confirm that most of the students can work out the reaction forces for a simple structure, which is promising for the first sessions.

Figure 15a–e shows very interesting findings. Although, in each question, more than 50% of the answers were correct, the questions looked challenging to the students, especially when it came to Figure 15c. This means that the students struggled with the deep concepts in a good way and were left in a position to think and learn. It should be noted that teaching the differences between internal and external forces is always challenging, and the authors believe that the designed polls were very helpful.



(**a**)



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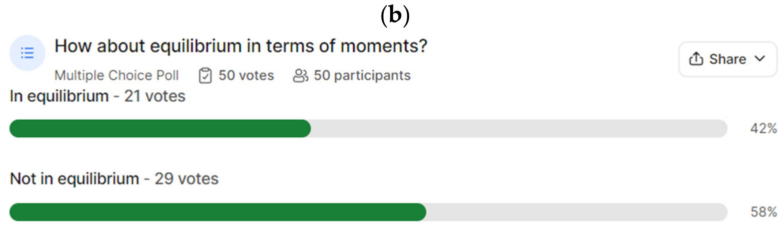

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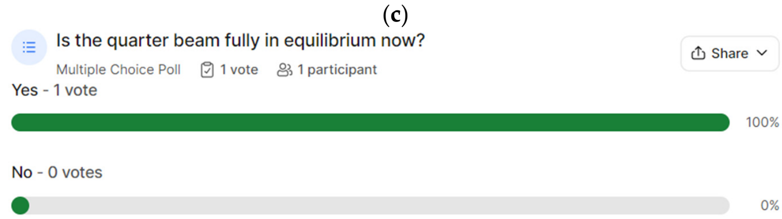

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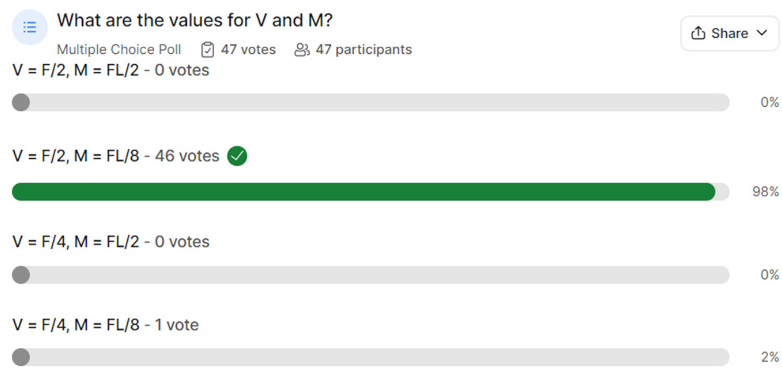

(**e**)

Figure 15. Interactive feedback for poll 3.

2.3. Polls on Stresses (Polls 4 and 5)

Polls 4 and 5 were designed to support students' learning on the topic of flexural and shear stresses. They need to gain knowledge about stress distributions and differences between flexural and shear stress, which are key components of the mechanics of solids. Table 3 lists the questions related to these polls. These polls were implemented in week 8 of the semester. The first question challenges the students on if they know the distribution of bending stress in a beam cross-section or not. The second question targets the role of the cross-section geometry in the bending stress distribution in a beam with the same bending moment diagram. The third question challenges the students on if they know the shape of the shear stress distribution considering the geometry of the cross-section. The last two questions are also focused on the shear stress distribution in T-shaped cross-sections.

Table 3. Bending and shear stress questions.

Poll Description	Questions
Bending Stress	(a) The beam in the figure is under bending; in a cross-section of the beam, which point has the maximum stress? (See Figure 16) ☐A ☐B ☐C
	(b) Which load setting creates more stress in the beam? (See Figure 17) ☐A ☐B
Shear Stress	(c) The shear stress distribution over a rectangular cross-section of a beam follows ☐A straight-line path ☐A circular path ☐A parabolic path ☐An elliptical path
	(d) A T-section is subjected to a shear force F. The maximum shear stress will occur at (see Figure 18a): ☐Top surface ☐Neutral axis ☐Bottom surface
	(e) A cantilever beam of a T cross-section carries a uniformly distributed load. Where does the maximum magnitude of bending stress occur? (See Figure 18b) ☐At the top surface ☐At the junction of the flange and web ☐At the mid-depth point ☐At the bottom surface

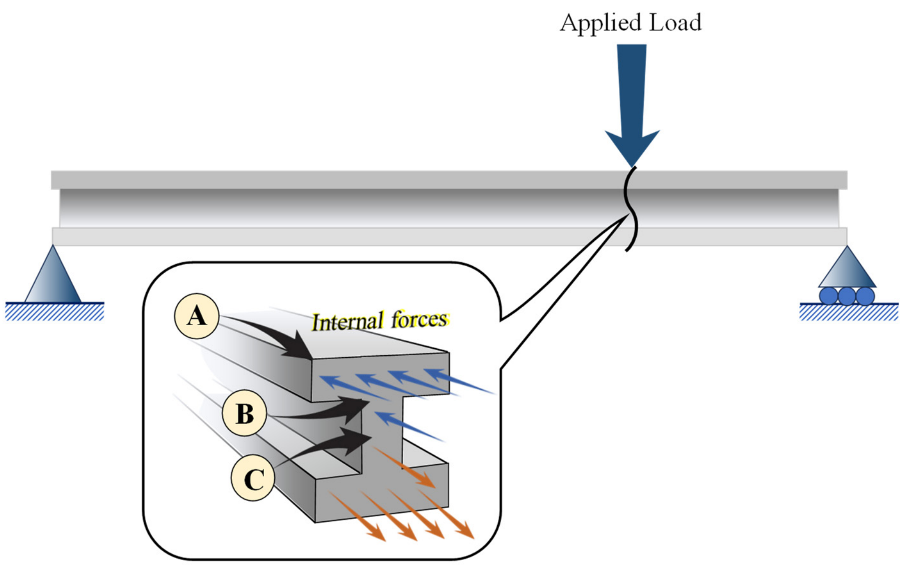

Figure 16. The beam in the figure is under bending; in a cross-section of the beam, which point has the maximum stress?

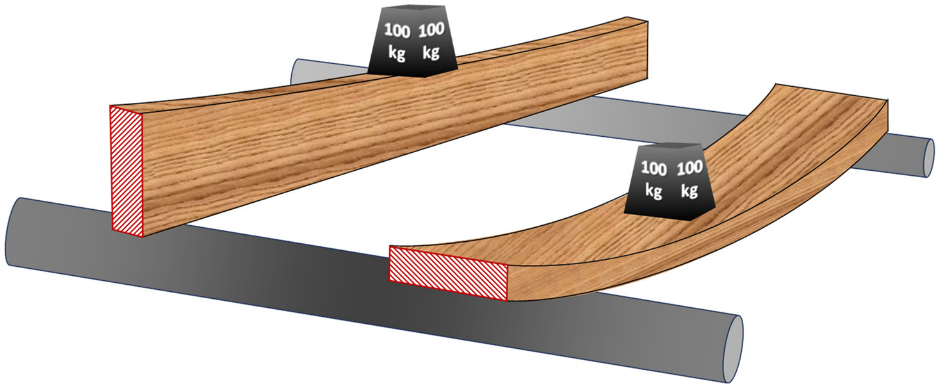

Figure 17. Which load setting creates more stress in the beam?

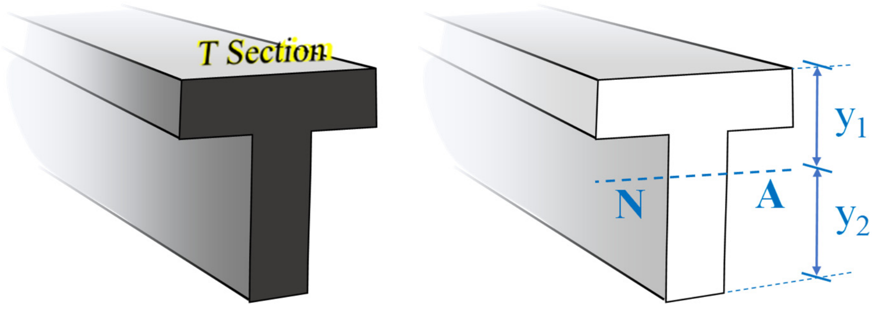

Figure 18. (**a**) The maximum shear stress of a T-section is subjected to a shear force, and (**b**) a cantilever beam of a T cross-section carries a uniformly distributed lead. Where does the maximum magnitude of bending stress occur?

Two polls were considered for this part (i.e., polls 4 and 5), and 63 and 78 students logged in to polls 4 and 5, respectively. A total of 53 and 64 students actively participated (voted for at least one question in the poll). The students' feedback is shown in Figure 19a–e. The results show that the first two questions were slightly challenging for the students, while they showed a reasonably good understanding of shear stress distributions.

2.4. Poll on Deflections (Poll 6)

For the last section of the module, only one poll was designed. Table 4 shows the question and the options provided. The main purpose of this question was to emphasise the importance of deflection, in addition to the stress calculation in the structure design process. This poll was implemented in week 9 of the semester.

Table 4. Deflection questions.

Poll Description	Questions
Beam deflection	When you design a beam, you need to select a beam section in which: ☐A given maximum stress level is not exceeded ☐A given maximum deflection is not exceeded ☐A given maximum stress level AND a given maximum deflection are not exceeded

As this session was delivered in the last weeks of the semester, there were only 55 students logged into this poll, and 50 of them participated, representing approximately 91% of the present students. The students' feedback is presented in Figure 20, which confirms that the students have a good awareness of the importance of deflection calculation.

Figure 19. Interactive feedback for polls 4 and 5.

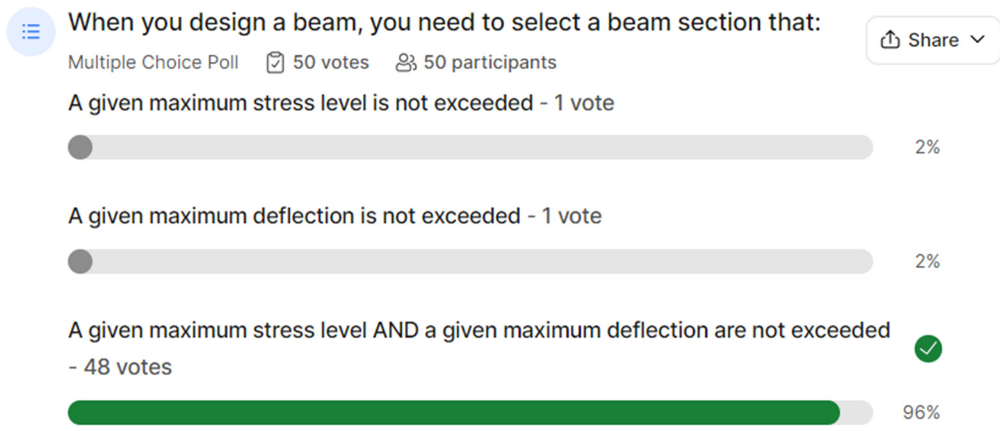

Figure 20. Interactive feedback for the deflection poll.

3. Quantitative and Qualitative Analysis

In this section, a quantitative and qualitative analysis is performed to evaluate the impact of using the online platform on enhancing the students' engagement in this module.

3.1. Student Participation and Engagement

Figure 21 shows the student participation in each poll. This figure indicates that the number of students who participated generally decreases closer to the end of the semester. Unfortunately, this is a trend that is observed every year for most modules. The students normally face a huge volume of coursework and continuous assessment closer to the end of each semester and prefer to avoid attending the lectures. Figure 21 also presents the comparison of logged-in and engaged students in the classroom for different polls. The poll numbers are on the x-axis, and the number of students is on the y-axis. Figure 22 shows the percentage of engaged students by poll number. The figure also displays that the percentage of engaged students is generally higher in later polls. This confirms that more students are engaged in the learning process as the semester progresses. Both figures confirm this. This shows that more students are simply present in the classroom but not actively engaged in the learning process. However, the latest polls indicate a slight improvement in student engagement.

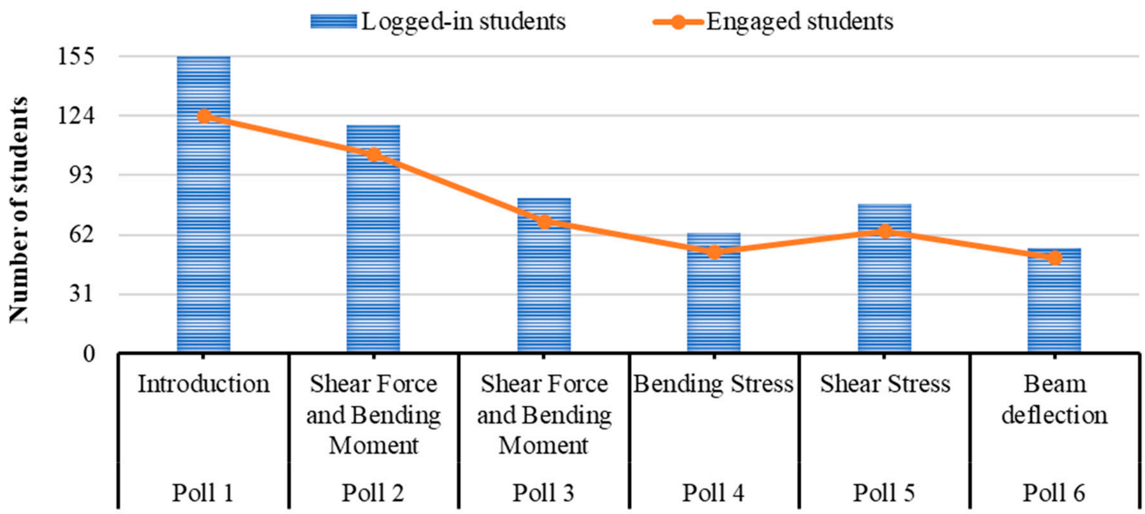

Figure 21. Comparison of logged-in and engaged students in the classroom for different polls.

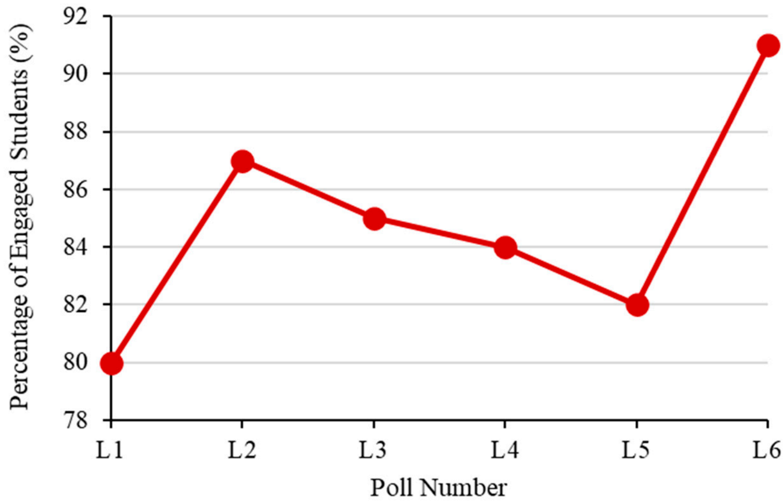

Figure 22. Percentage of engaged students.

3.2. Student Feedback

In order to evaluate the effectiveness of the proposed approach in the students' engagement, a final poll was designed to receive feedback from the students. In total, the students were asked five feedback questions. Figure 23 shows the first question and the responses received from the students. The lecturer employed a variety of teaching methods, including the approach proposed in this paper. So, the question asks the students if this helped them to be engaged through the semester. As can be seen in this figure, most of the students found the combination of diverse teaching methods to be effective in maintaining their engagement. A total of 22 students rated it as "very good" and 6 students rated it as "excellent".

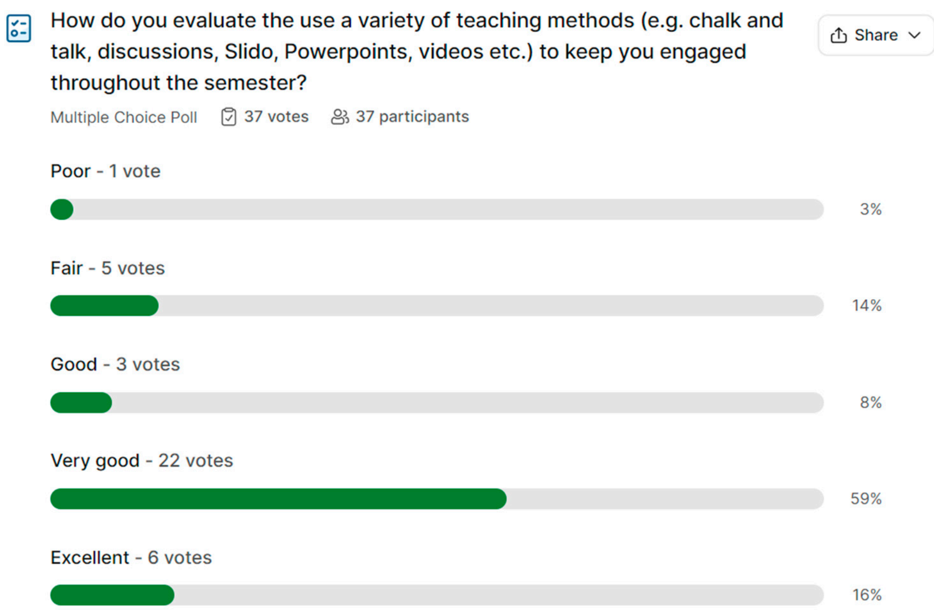

Figure 23. Students' evaluation of teaching methods for engagement.

The next question is directly focused on the online technology used in this study. The students are asked if the use of Slido enhanced their learning experience or not. Figure 24 shows that a significant majority of the students believed that their experience was positive. A total of 12 students voted for "good", 12 students voted for "very good", and another 8 students voted for "excellent".

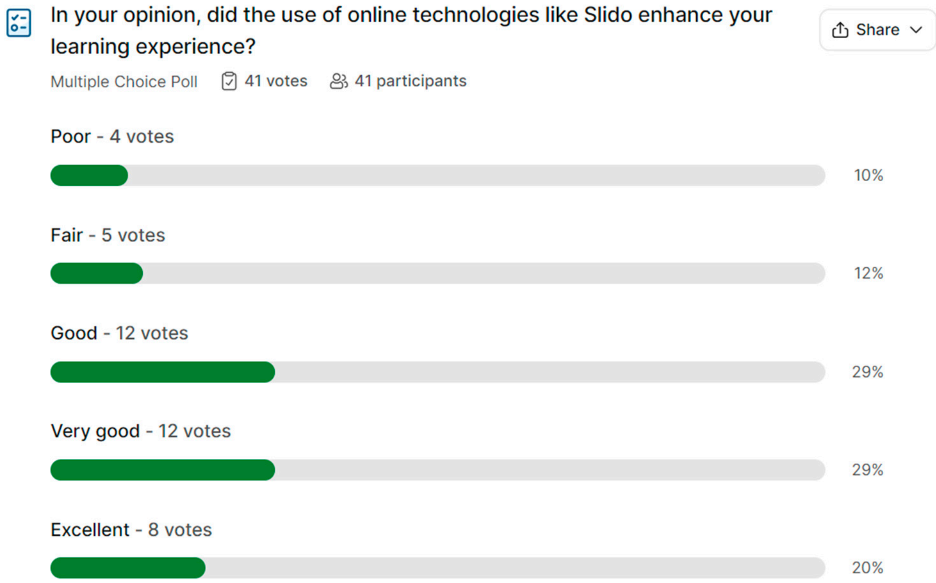

Figure 24. Students' assessment of the online technology's impact on their learning experience.

Figure 25 depicts the students' opinions on the effectiveness of the novel approach in course engagement and discussion participation. The students again highly voted for the positive effect of the proposed approach on their engagement. Totals of 7, 13, and 8 students voted for "good", "very good", and "excellent", respectively.

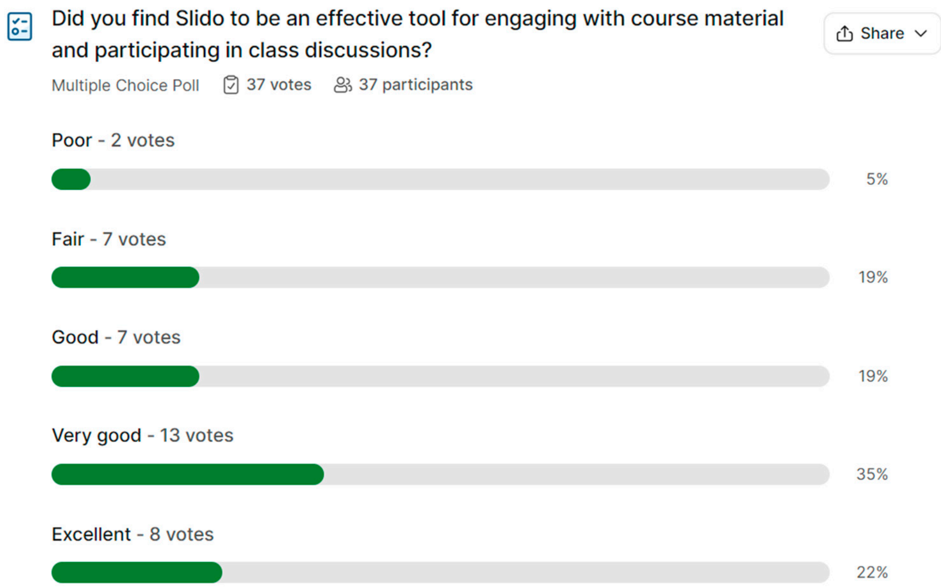

Figure 25. Identified effectiveness of Slido in course engagement and discussion participation.

One of the main challenges regarding using novel technologies in teaching and learning in higher education is the factor of being user-friendly. Many of the proposed solutions might be very useful, but they are hard to access and use. The next question asks the students how easy it was for them to access and use the online technology in this course. Figure 26 shows very strong and positive feedback to this question, which is very encouraging.

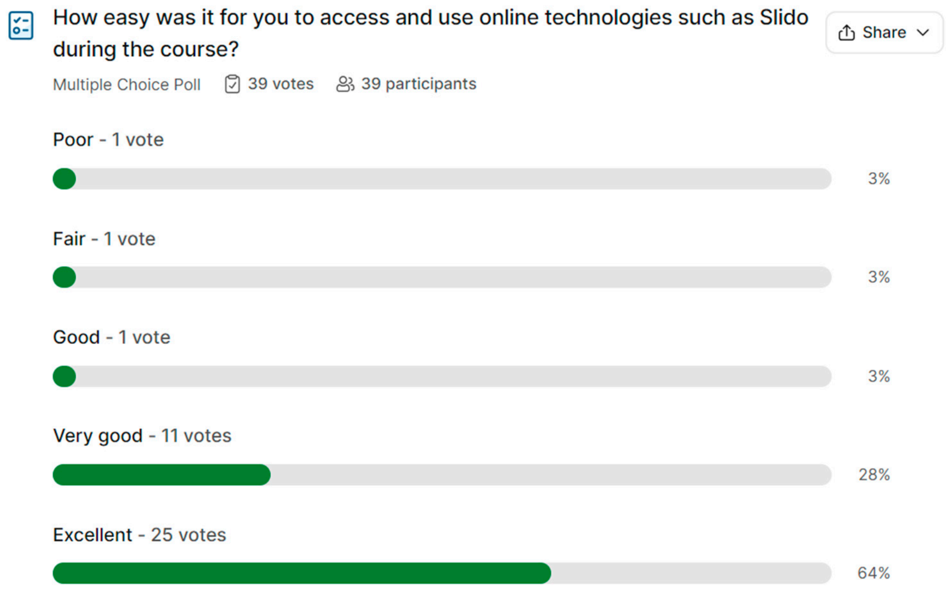

Figure 26. Access to and use of online technologies.

The last question addresses the potential of online technologies, e.g., Slido, in enhancing learning for challenging courses such as "Mechanics of Solids". Students were generally positive about the use of online technologies in understanding the "Mechanics of Solids" module. As can be seen in Figure 27, 76% of the students rated it as "good" or above, with 38% considering it "very good" or "excellent." In contrast, 24% of the students found it "fair" or "poor", indicating room for improvement.

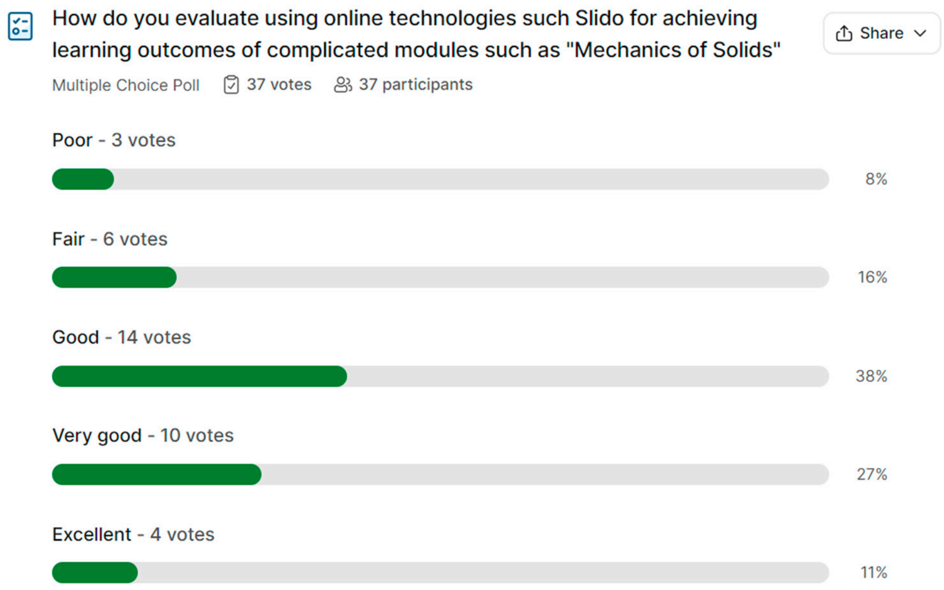

Figure 27. Assessment of online technologies for learning outcomes in Mechanics of Solids.

It can be summarized from the feedback poll that the students reported that they felt more involved in the learning process, and they appreciated the interactive and engaging nature of the online activities. However, there are still some aspects in which the proposed approach can be improved.

4. Conclusions

In this paper, a novel and integrated approach is proposed using an online polling platform to improve student's engagement in a highly theoretical engineering module, e.g., Mechanics of Solids, where the size of the class is relatively large. The proposed approach was implemented while delivering this module in September 2024. Several specific questions were designed in the format of online polls, where the students can vote for multiple-choice questions and see the answers from other students online. Each poll is designed for an individual topic, such as the bending moment and shear force, stresses, and deflections. The participation rate and results of each poll are extensively discussed in this paper. In addition, a quantitative analysis of the participation is presented to show the trend of the students' engagement throughout the semester. Finally, a feedback poll is employed to qualitatively evaluate the effectiveness of the proposed approach.

The results show that the students' engagement throughout the semester significantly improved. Although the number of students attending the lectures decreased over the semester, the number of students who participated in the activities stayed high. The visual observation from the traditional teaching methods employed in previous years is that only 5–10 students normally participate in the discussions, while when using the proposed approach, 60–120 students participated. This can be considered a huge success in delivering an engineering module. It can be concluded that by incorporating interactive elements developed with novel technologies into the classroom, these platforms can break down traditional barriers, enhance active engagement, and promote a more dynamic learning environment. For the specific module in this study, Mechanics of Solids, high levels of participation and feedback and improved understanding of key concepts emphasise the effectiveness of the proposed approach in enhancing the learning experience.

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Conflicts of Interest: The authors declare no conflict of interest.

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