International Journal of Engineering Education Vol. 40, No. 3, pp. 499–510, 2024
Printed in Great Britain

0949-149X/91 $3.00+0.00

Comparison Between In-person Versus Virtual Case-based Learning for an Upper Year Course in Engineering Technology Education*

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Case-based learning (CBL) is an established learning approach adopted by various disciplines which challenges students to solve real world problems, resulting in achieving higher levels of cognition. This active-learning pedagogical method has been continually practiced in several courses taken by students in the undergraduate engineering technology program, Biotechnology at McMaster University. The intent of this study is to compare the perspectives of students on the effectiveness of virtual CBL versus in-person CBL, directed pre- and post-pandemic respectively in the upper year course of the program, Industrial Biotechnology completed in Fall 2021 (conducted virtually) and Fall 2022 (conducted in-person). The resultant findings indicate that CBL proved to be a superior learning tool for an in-person delivery platform, opposed to a virtual platform. Although students in a virtual learning environment stated that CBL did not have a major effect on their communication and teamwork skills, majority of them agreed that CBL enhanced their critical thinking skills, problem-solving skills, course performance, self-confidence, and exhibited a deeper conceptual understanding. Acclimatized with the virtual learning environment, students also found it challenging to reform back to an in-person learning environment.

Keywords: CBL; virtual learning; in-person learning; engineering technology; biotechnology; education

1. Introduction

Case-based learning (CBL) and problem-based learning (PBL) are the two active-learning and interactive pedagogical methods widely practiced in business, law, medical, and engineering education. Although both these approaches focus on improving the problem-solving skills of students by resolving real world industry cases, deceptive terms such as ''case-based problem-based learning [1]'' have often mislead readers regarding the opposing nature of these two methods.

CBL originally emanated at Harvard University by the Dean of the Harvard Law School in the year 1870. Professor Christopher Columbus Langdell assembled a legal casebook comprised of preceding case laws to devise a learning system established solely on the use of cases [2]. The casebook served as a doctrine for law students to learn from history and simplify legal education for the future. Following the footsteps of the Law School, the Business School implemented their own casebook in the 1920's to dominate the rapidly growing business environment. The objective of the case study method was beyond transferring the knowledge obtained from lectures to case studies, but ''to acquire a broad acquaintance with both technical and general information about diverse fields of industry, not by the study of dissociated facts but as an incident in the intellectual process of working out decisions [3]''.

PBL was formerly discovered at McMaster University by the Dean of the McMaster University Medical School in 1969 [4]. Opposed to the monotony and uniformity of traditional lecture-based learning, Dr. John Evans was the first to implement problem-based learning in the undergraduate medical programme. His goal was to help medical students solve real-world clinical problems in a self-directed manner, resulting in the overall experience being more motivating for the students. Dr. Evans described his prime objective for this implementation as, ''The ability to identify and define health problems, and search for information to resolve or manage these problems [4].''

The similarities of CBL and PBL include that both these methods directed the approach of seeking solutions to problems outside the perimeters of a traditional textbook, indicative of the open-ended nature of the cases at hand. Both methods were practiced in small-scale discussion groups in the classroom however, PBL differs from CBL in the way the material is presented to the classroom. For CBL at Harvard University, the cases were provided to the students in advance to infer individually, after which they were discussed in small groups. Opposingly in PBL at McMaster University, the problems were first analyzed in small

* Accepted 2 March 2024.

groups, after which the students protracted to a self-study period [3]. Hence, students practicing PBL were underprepared and lacked guidance during case discussions to successfully meet the objectives of the method.

The incorporation of methods such as CBL in engineering technology education has not only been beneficial in increasing the relevance of learning for students, but also emphasized the importance of professional behaviour and provided them with exposure to future responsibilities. By preparing students with these skills prior to graduation, it will be easier for them to adapt to their respective professional industries post-graduation.

Although engineers in the past have been capable of solving complex industry problems following a very methodical and systematical approach, engineers of the future must be groomed to be able to tackle problems associated with the rapid development of science and technology in this global world. Engineers are known to approach challenges with the help of pre-defined problem-solving paradigms [5]. Also known as deliberate strategy, these paradigms are designed to help students solve problems by categorizing them into what is provided, the goals, and the assumptions [6]. However, a change in the goals and assumptions implies a paradigm shift, and the students are no longer able to apply the strategies at hand. Moreover, the resulting paradigm is now an inaccurate and futile model [7], requiring the need for students to become their own leaders and decision-makers.

Efficiency and innovation [8] are the two learning domains identified that must be incorporated during teaching in order for students to exercise accurate decision-making. CBL encompasses both these parameters since it necessitates applying the relevant knowledge learnt in lectures to efficiently solve the case, and at the same time, allows for students to explore creative solutions outside the dimensions of a textbook to solve a problem innovatively. The possession of efficient and innovate problem-solving skills signify the development of not only successful future professionals, but also the creation of young entrepreneurs [7].

The prime objective of CBL is to encourage student participation and enhance student learning via active classroom discussions. Due to the covid-19 pandemic, educational institutions were compelled to adapt to a virtual-based learning system, disturbing the ease of face-to-face classroom discussions. As instructors faced many challenges to deliver information effectively using online platforms, students endured difficulties learning remotely. Instructors needed to work twice as hard in making students comfortable by offering a sense of community [9] to continue individual active classroom participation virtually.

Many students faced distractions studying in the comfort of their homes and were unable to create a focused learning environment. Online conferencing platforms also came with numerous technical hindrances, including video lag, as a result of network problems. Unable to interact with the instructor and peers face-to-face, student communication began to decline as students felt apprehensive and shy to express their opinions, especially those who were already introverted. Students were able to hide behind their computer screens and began to disengage themselves from participation [9]. Social interactions are a crucial part for an individual's psychological well-being [10]. The social withdrawal of in-person communication led to a decrease in social engagement and performance online, as it was difficult for instructors to monitor each individual's participation virtually.

Despite the disadvantages stated above, online-learning does materialize its own set of advantages too. Students who were hesitant to deliver their opinions in-person were able to convey them without the fear of judgment anonymously via an advanced polling system, offered by Zoom i.e., a virtual communications technology company. Introverted students, and those requiring additional time to answer were provided the space and opportunity to express themselves better [11]. They were also able to connect with the instructor personally via Zoom's person-specific private chats to engage in a one-on-one conversation. By assigning students to automatically created breakout rooms on Zoom, students were contrived to get out of their comfort zones by interacting and holding small group discussions with a randomized group of peers each time.

Online learning also deemed a beneficial tool in encouraging students to taken on the ownership of self-learning and self-motivation upon themselves. Asynchronous learning provides students with more time to conduct additional research on the topic of interest on the internet independently. Researchers have also found that students tend to occupy more time in analyzing problems in-person whereas, they were able to spend more time in solving the problems asynchronously [9].

2. Methodology

The objective of this pedagogical study was to compare the effects of CBL on student learning and development via the two different delivery formats, virtually conducted CBL and in-person CBL. The study was directed by requesting students to fill 10-item anonymous survey, where they were

asked to rank their opinions on the effects of CBL on their critical thinking, teamwork, communication and real-life technical skills, course performance, self-confidence, learning experience, deeper and conceptual understanding, and application. The ranking was executed using a five-point grading scale as follows; 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree.

The participants of this study comprised of students in the third year of the undergraduate engineering technology program offered at McMaster University, Biotechnology. This study was devised for students in the course Industrial Biotechnology, completed in Fall 2021 (conducted virtually) and Fall 2022 (conducted in-person). Hence, the study evaluates the opinions of two different graduating cohorts having undertaken the same course and solved identical case studies to minimize variability in the learning experience, irrespective of the delivery format.

Retrieving data from two separate graduating cohorts also implies that these students had the opportunity to witness both delivery formats of CBL in other undergraduate courses taken, prior to, and during the pandemic. Consequently, they were able to provide conscientious and valuable insights on the differences between both the delivery formats in question. And therefore, students undertaking the course in Fall 2022 were asked to provide their opinions using second anonymous survey on the effect of virtual versus in-person CBL on their attitudes during the learning process to examine if they experienced frustration, felt active, motivated, engaged, or underwent challenges or confusion. Lastly, they were asked if CBL aided in developing a better understanding of concepts for them, or if they required additional means of guidance from the instructor [7].

Case study setting: The case studies were solved in class by student teams, each team consists of three students with the instructor as facilitator. There were ten case studies over the term, one case study every week except first and last weeks of the term. The topic of the weekly case studies was related to the lecture topic of that week. Each team answered the case study questions in class in the last 30 min. of the 50 min. lecture and submitted as team report.

3. Results and Discussion

3.1 The Effect of Virtual Versus in-person CBL on the Learning Experience

3.1.1 The Effect of CBL on Critical Thinking

The incorporation of evidence-based learning in undergraduate education curriculum has known to improve critical thinking skills of students by providing them with more clarity, precision, and appropriate reasoning essential for decision-making [12–14]. Fig. 1 presents the responses of students on the effect of CBL on their critical thinking skills. Combining both cohorts, the majority, i.e., 73% of students in an in-person CBL setting, and 62% of students in a virtual CBL setting agreed, or strongly agreed that case studies improved their critical thinking skills. Additionally, 17% of students from both delivery formats strongly agreed that CBL improved their critical thinking skills. This implies that regardless of the delivery format, students were able to collaborate and actively participate in group discussions to devise a solution to the case at hand cohesively.

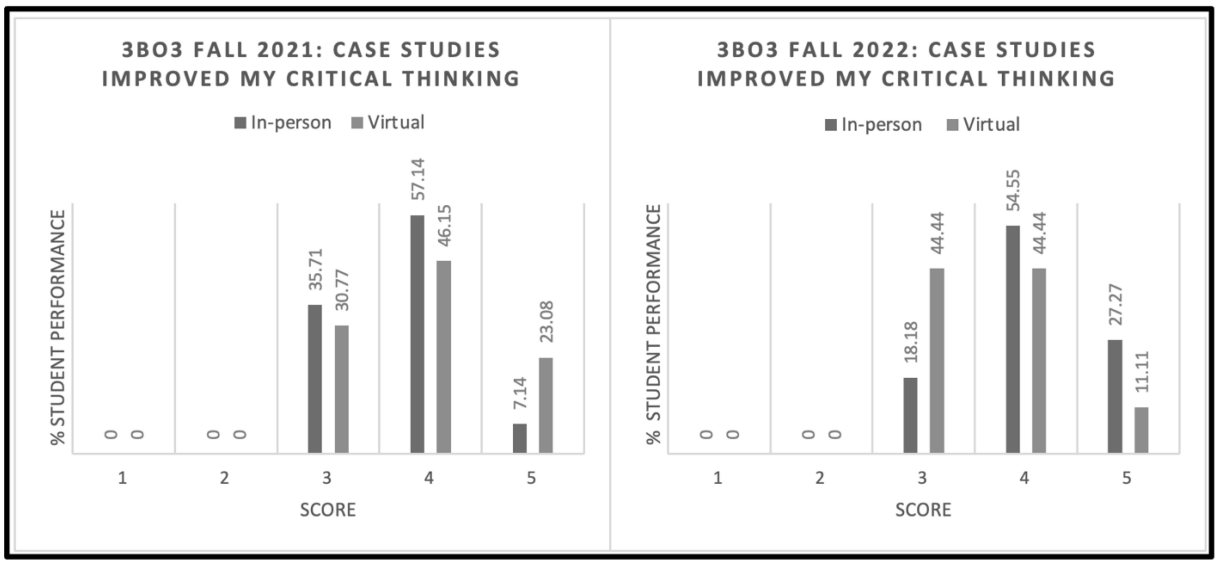

Fig. 1. Case studies improved my critical thinking.

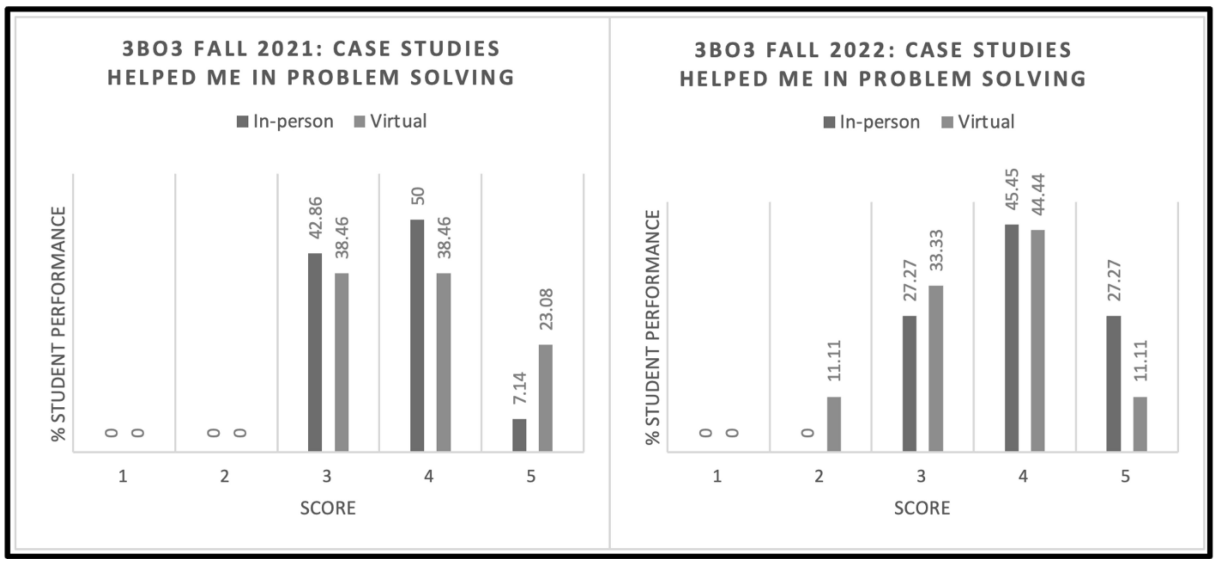

Fig. 2. Case studies helped me in problem solving.

Group discussions are crucial in the development of critical thinkers, as it allows students to diagnose problems more creatively and effectively by analyzing the unique perspectives of other peers.

3.1.2 The Effect of CBL on Problem Solving

CBL is responsible for providing students with real-life cases for them to solve industry-level challenges, in preparing them for the professional world [15, 16]. With the main objective of case studies being testing the ability to problem solve, Fig. 2 demonstrates that in both graduating cohorts for both delivery platforms, majority students agreed or strongly agreed that case studies helped them in problem-solving. In the case of students undertaking the course in Fall 2022, conducted in-person, 11% of students disagreed with this statement when associated with a virtual CBL learning environment. With the students of this cohort having previously been subjected to an online-based CBL platform, the disagreement could be a result of a variety of factors including virtual learners having open access to solutions on the internet, resulting in them finding the cases less challenging. The virtual environment also poses the threat of academic dishonesty since peers can share their solutions amongst one another via networking platforms. This leads to the inability for students to problem-solve independently.

3.1.3 The Effect of CBL on Teamwork

CBL aims to teach students the value of teamwork by allowing students to collaborate and solve cases in small discussion groups. Teamwork extends beyond just placing students in discussion groups, it requires the input and active participation of each team member. Virtual discussion groups lead to the decrease of team collaboration because of technical difficulties and the lack of face-to-face discussions, making it challenging for students to settle into the natural rhythm of conversations. Consequently, team members might feel disconnected from one another, preventing them from participating equally. This is evident by the statistics depicted in Fig. 3, with 33% of students in the Fall 2022 division disagreeing to CBL having helped them to practice teamwork in a virtual setting, and 11% with strong compliance to this statement. Contrastingly, majority students in both cohorts complied with this statement when associated with in-person CBL, having had the privilege of interacting with their group members in-person. CBL is also known to increase student performance to a greater extent when working in groups, as opposed to students solving cases individually [17].

3.1.4 The Effect of CBL on Communication Skills

Case studies have been proven to be more effective than textbook readings in enhancing written and oral communication skills [18, 19]. Fig. 4 illustrates the effect of CBL on the communication skills of students. Majority of the students in both cohorts agreed or strongly agreed that case studies played a major role in improving their communication skills when in a synchronous learning environment. Contrastingly, when practicing CBL in a virtual setting, 15% of students in the Fall 2021 division and 11% of students in the Fall 2022 division disagreed with this statement.

One of the major challenges associated with virtual communication is the disparity in how each individual person chooses to communicate.

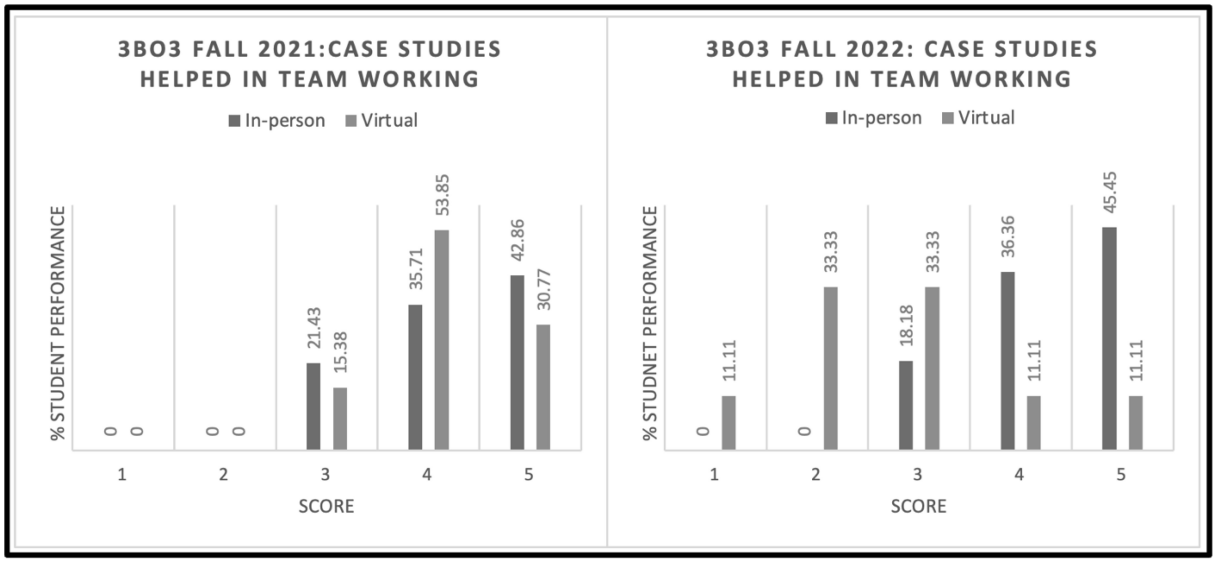

Fig. 3. Case studies helped me in teamwork.

With each student possessing their own unique style of communication, this can lead to the loss of information, resulting in ineffective communication within the group. Hence, it is important for individuals within a group to coordinate and choose a means of communication which suits the group as a whole for them to be best productive. A virtual learning environment also posed challenges on the instructor for monitoring if all students were able to communicate their ideas freely during online group discussions, especially those introverted.

3.1.5 The Effect of CBL on Real-life Technical Skills

With the rapidly growing technological world, engineers must be prepared to face challenges with skills broader than those acquired by reading textbooks [20]. CBL has deemed advantageous in several healthcare and medical programs by granting students with the necessary and practical technical skills [21]. The effect of CBL on the real-life technical skills of students is depicted in Fig. 5. Majority of the students in both graduating cohorts either perceived a neutral viewpoint or disagreed towards CBL improving their real-life technical skills when in a virtual CBL learning environment.

Combining the opinions of both cohorts for CBL in the virtual setting, 25% of students expressed that CBL had no influence in improving these skills. Real-life technical skills comprise of both cognitive and psychomotor skills. Hence, the incorporation of CBL might not be sufficient to encompass both

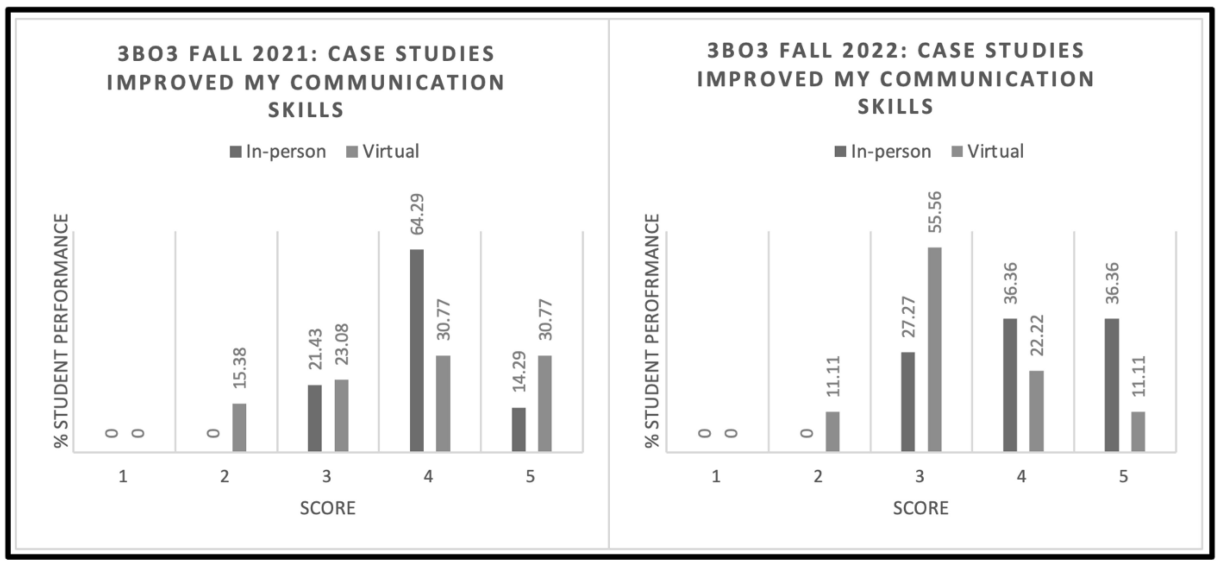

Fig. 4. Case studies improved my communication skills.

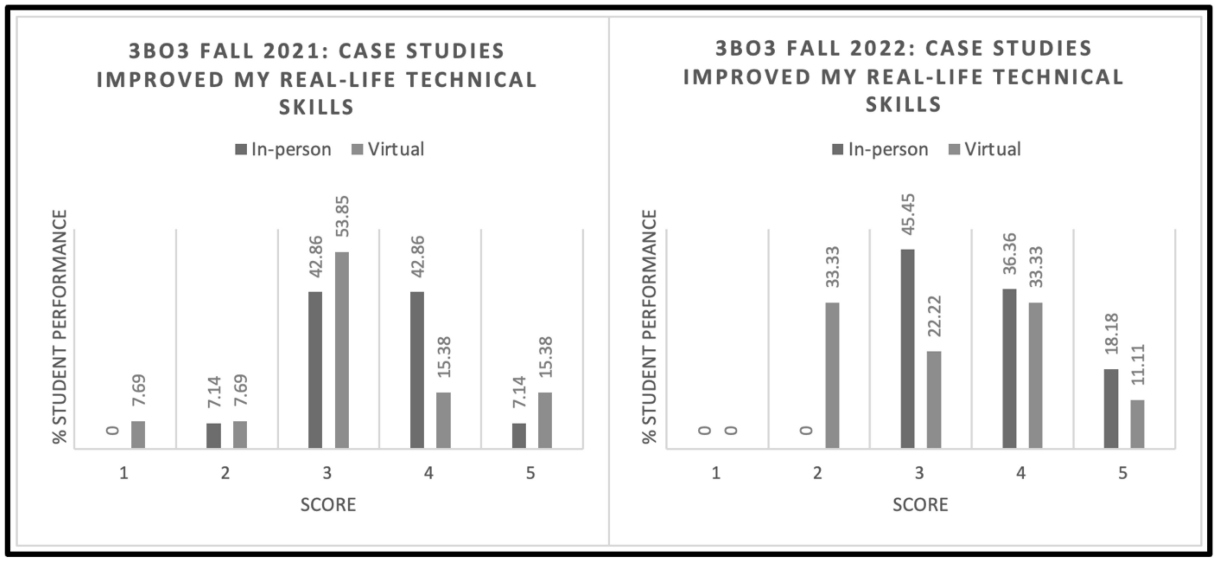

Fig. 5. Case studies improved my real-life technical skills.

these categories of skills, especially in a virtual environment. A combination of simulations and CBL could potentially result in enhancing the technical and nontechnical proficiency of students [22]. Further studies must be conducted to examine the effects of CBL on both, cognitive and psychomotor technical skills.

3.1.6 The Effect of CBL on Course Performance

The case studies presented to students are constructed from topics within the syllabus that the students are already familiar with, and therefore they can use the concepts taught in class efficiently by applying them to solve cases. The results displayed in Fig. 6 demonstrate the positive impact of CBL in helping 67% of students in both cohorts and delivery platforms improve their course performance. This is compliant with previous studies performed, where it was found that CBL was able to improve the grades of students by nearly 55% [23] and enhance their overall student learning and performance [24]. The results also indicate that regardless of which platform CBL was exercised through, no students opposed the influence of CBL on their course performance.

3.1.7 The Effect of CBL on Self-confidence

The adoption of CBL has known to be associated in proliferating the self-confidence of students [25]. The self-confidence of a student increases when they can answer questions accurately. Since the participants of this study were third year under-

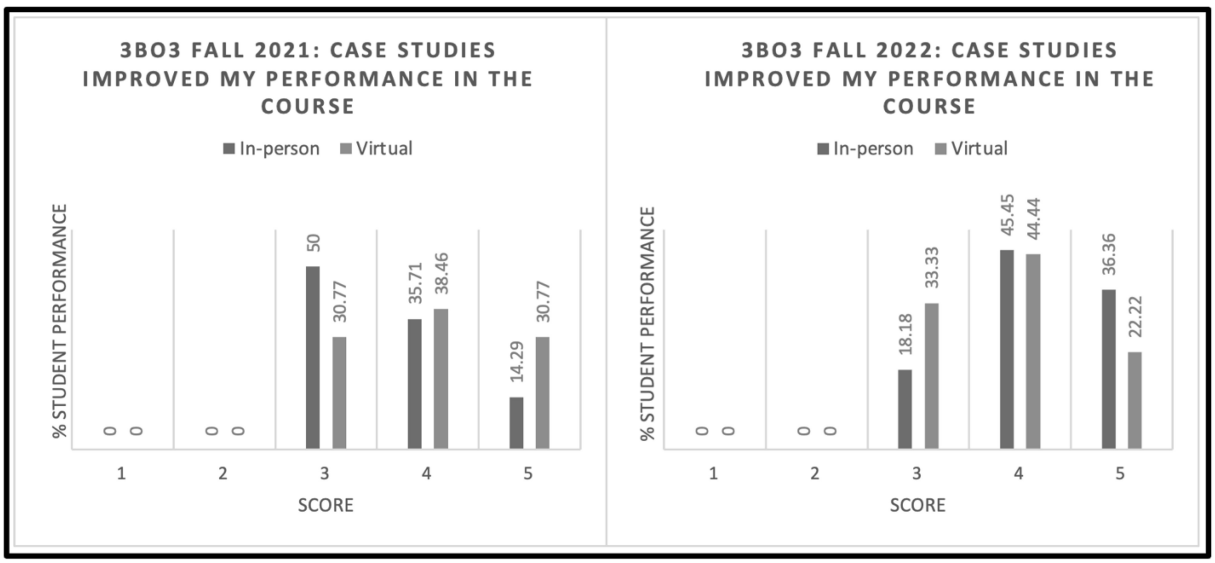

Fig. 6. Case studies improved my performance in the course.

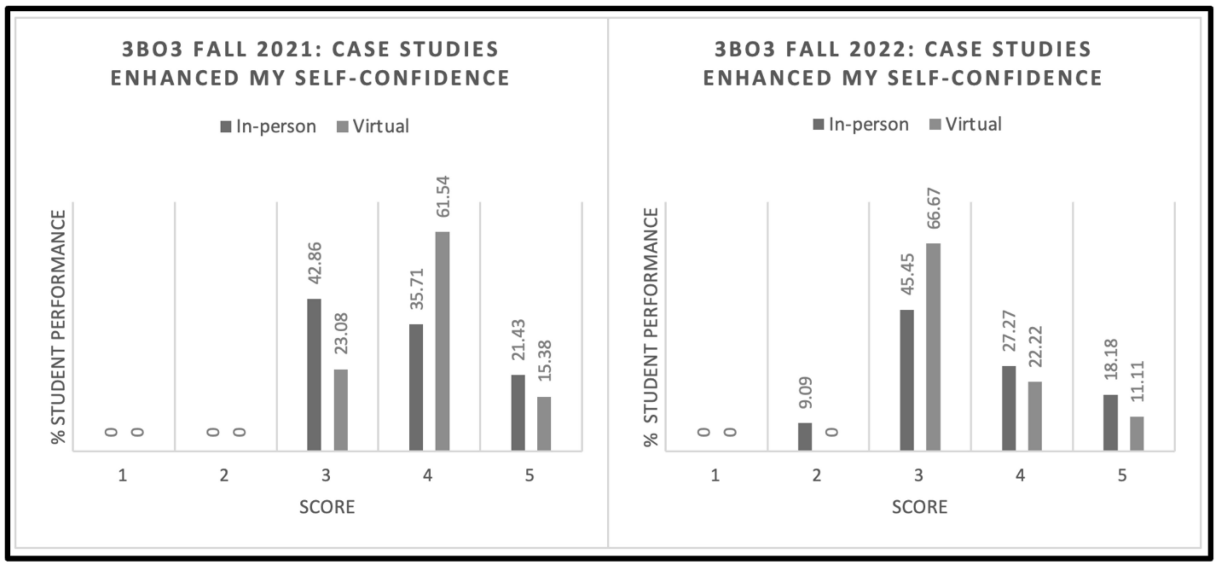

Fig. 7. Case studies enhanced my self-confidence.

graduate students who had already been exposed to CBL beforehand, they were already familiar with the framework that CBL entailed. Hence, the students had already obtained sufficient practice solving cases prior to taking this course and were able to solve cases more confidently. This is evident in Fig. 7, which showcases the perceptions of students on CBL enhancing their self-confidence.

Majority of students in the Fall 2021 division agreed or strongly agreed that CBL helped enhance their self-confidence, irrespective of the delivery platform. Contrastingly, 67% of students in the Fall 2022 division perceived neutrality with this statement, when bound to a virtual CBL setting. Furthermore, 45% perceived neutrality with this statement when associated with in-person CBL learning environment, while 9% disagreed. The divergent opinions of students in the Fall 2022 cohort implies that previously subjected to a virtual learning environment, the students in this division were accustomed to the virtual delivery format of CBL. The online environment depleted their self-confidence in learning material while solving cases by offering them the ease of finding solutions on search engines. This resulted in the students feeling doubtful and insecure about expressing themselves when in-person, causing them to question their self-confidence, and the validity of their solutions.

3.1.8 The Effect of CBL on Learning Experience

By bridging the gap between theoretical knowledge and application, CBL offers life-long learning skills for students. Studies show that the introduction of CBL in a clinical setting resulted in all the students i.e., 100% of them showcasing improvement in their learning [23]. Fig. 8 presents the influence of CBL in improving the overall learning experience for students. Wherein, majority of the students in both cohorts comply with this statement with respect to both CBL delivery platforms. Opposingly, 11% of students in the Fall 2022 division disagreed with this statement when in a virtual classroom setting. 46% of students in the Fall 2021 division and 33% in the Fall 2022 division perceived neutrality for the same. With the pandemic having infiltrated into this world so abruptly and unexpectedly, all educational institutions were unprepared. Institutions struggled to transfer learning to an online platform efficiently, and instantaneously. Hence, it became difficult to replicate the in-person CBL experience virtually with access to limited resources and technology to do so, impacting the learning experience of students adversely. Additional factors include technical challenges, miscommunication, misinterpretation of information, lack of student-teacher engagement, and team coordination.

3.1.9 The Effect of CBL on Concept Understanding and Application

Case studies offer a creative and an interactive way to test students on the content being studied in the classroom, by using a narrative format. CBL has been recognized to be more effective than other methods to augment content delivery and comprehension [18]. Combining the results of both graduating cohorts (Fig. 9), 56% of students agreed that CBL enhanced their concept understanding and application in an-person classroom, and 47% agreed the same for when in a remote classroom. Students were able to identify concepts in the cases presented, which were previously studied in lectures

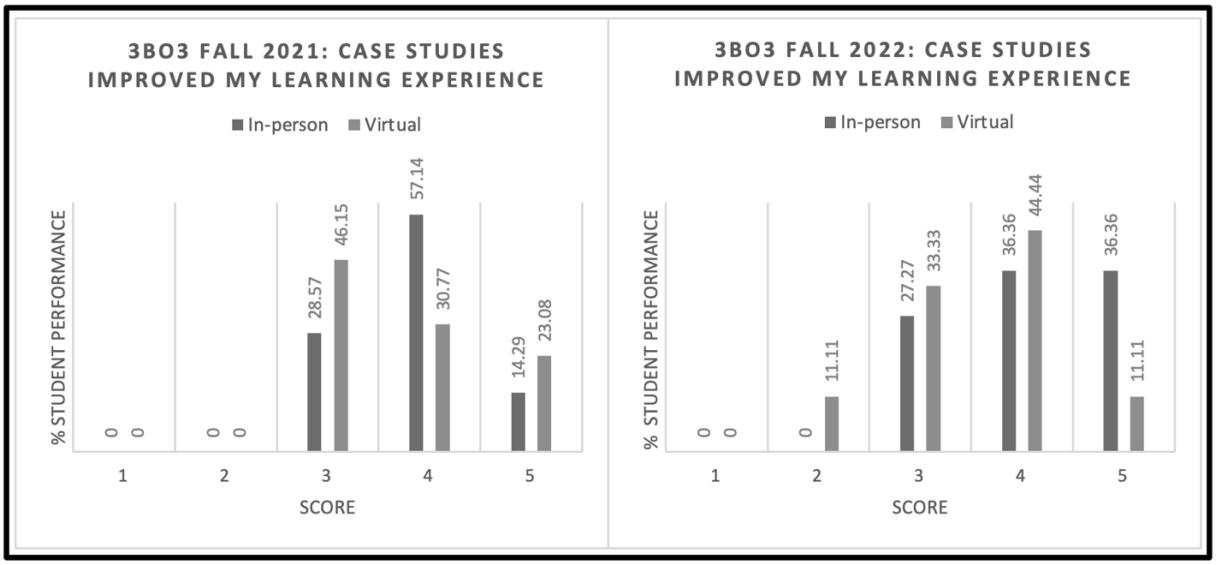

Fig. 8. Case studies improved my learning experience.

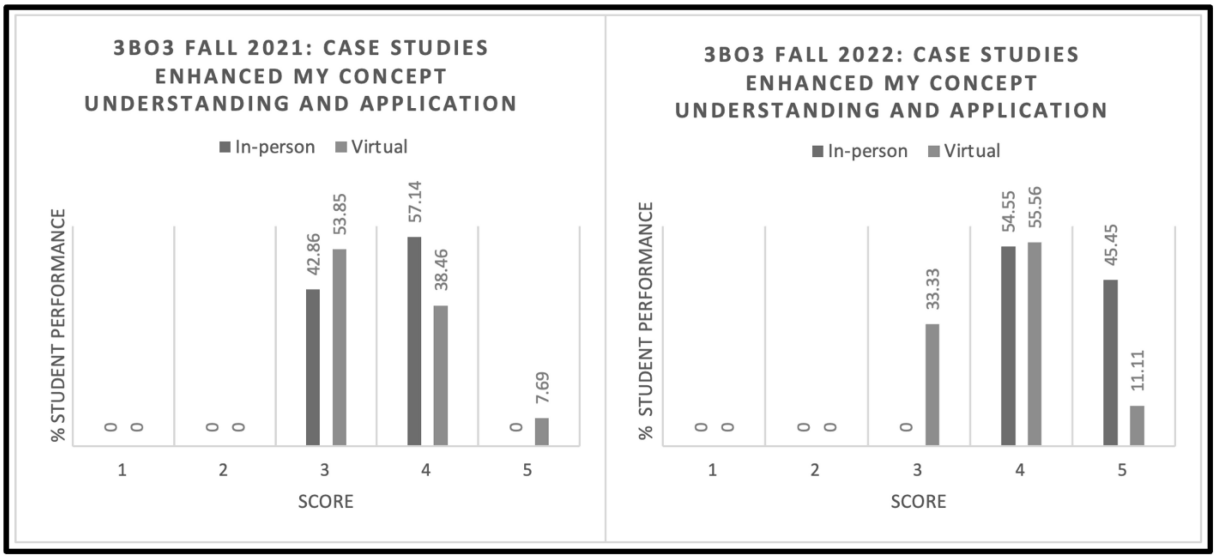

Fig. 9. Case studies enhanced my concept understanding and application.

and apply their course knowledge. The correct and accurate application of these course concepts implies that students were able to successfully understand the concepts being studied in class, directly fulfilling the purpose behind "course objectives."

3.1.10 The Effect of CBL in Deeper Understanding

CBL extends beyond responding to questions in the cases presented accurately but has also been associated with promoting deeper learning and behavioural changes amongst students [26, 27]. CBL has also known to emphasize learning objectives more than PBL, inducing a more profound level of learning [21]. As depicted in Fig. 10, case studies have helped in deeper understanding of information for majority of the students in both graduating cohorts and for both, in-person, and online delivery of CBL. By reflecting and applying knowledge learnt in lectures in case studies, students can establish a deeper understanding of concepts.

3.1.11 Overall CBL Evaluation

Irrespective of the delivery platform that CBL was presented through to the students, CBL impacted their overall learning experience positively (Fig. 11). 71% of students in the Fall 2021 division regarded CBL as a highly favourable active learning modality in their curriculum when delivered in-person, and 68% regarded it as the same when offered virtually. All the students in the Fall 2022 division strongly complied with this statement for CBL

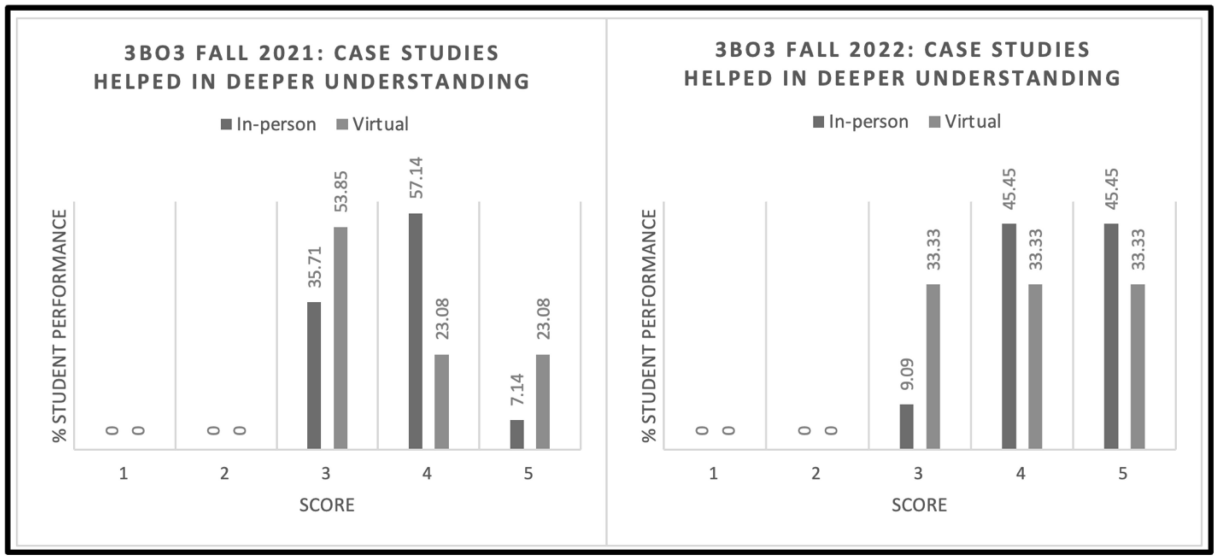

Fig. 10. Case studies helped in deeper understanding.

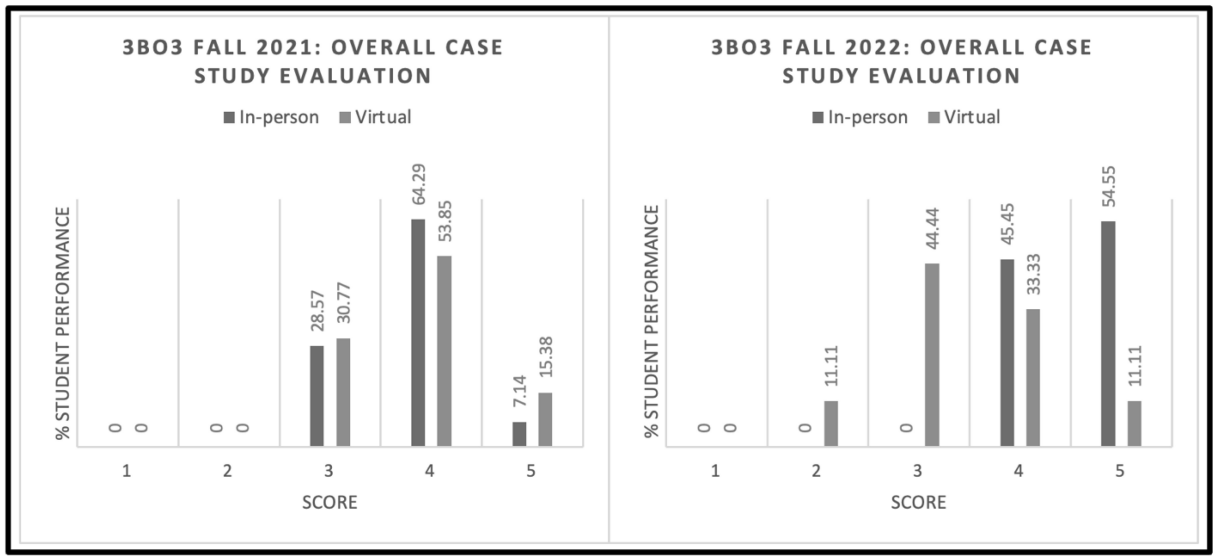

Fig. 11. Overall student evaluation of CBL.

offered in-person however, 11% from the same division disagreed with the statement for CBL offered virtually. The differences in the viewpoints of students in the Fall 2022 cohort on the delivery platforms of CBL indicates that after bearing a witness to both learning environments, the students recognize that CBL is unable to provide them the same learning experience virtually, as it would in-person.

Although CBL still deemed an advantageous learning tool when offered virtually, more students benefit from it in an in-person classroom environment. Despite the positive impacts of CBL mentioned, conducting CBL on an online platform fails to meet the prime purpose of the method, i.e., student engagement to facilitate active discussions.

3.2 Effect of in Virtual versus In-person CBL on the Learning Process

In addition to evaluating the influence of CBL on student learning, the effect of CBL on the attitudes of students during the learning process was also examined for students in the Fall 2022 graduating cohort. Table 1 illustrates the perceptions of students on the effect of CBL on their behavioural experiences in an in-person classroom setting and virtual. A total of 80% of the students agreed, or strongly agreed that they were able solve cases actively and developed a better understanding of the concepts in the in-person setting as compared with 60% for the cases study in the virtual setting. 50% of the students agreed or strongly agreed they were motivated with in-person case study as com-

Table 1. Comparison of learning process between in-person and virtual CBL

		% students' response with the case study:	
Question	**Score***	**In-person**	**Virtual**
I was frustrated	1	30	30
	2	30	30
	3	20	40
	4	20	0
	5	0	0
I was active	1	0	0
	2	0	10
	3	20	30
	4	60	40
	5	20	20
I was motivated	1	0	0
	2	20	10
	3	30	60
	4	40	20
	5	10	10
I was challenged	1	0	0
	2	10	20
	3	50	60
	4	40	20
	5	0	0
I was engaged	1	0	0
	2	20	10
	3	10	20
	4	50	60
	5	20	10
I was confused	1	20	20
	2	40	40
	3	30	30
	4	10	10
	5	0	0
I developed a better understanding of the concepts	1	0	0
	2	0	20
	3	20	20
	4	50	40
	5	30	20
I needed more guidance from the instructor	1	30	30
	2	40	20
	3	20	20
	4	10	30
	5	0	0
I learned more	1	0	0
	2	0	10
	3	30	50
	4	60	10
	5	10	30

* 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree.

pared with 30% in the virtual case study. 70% of the students stated they felt engaged via the use of case studies in both in-person and virtual setting.

Overall, 70% of the students agreed, or strongly agreed that they learned more with the incorporation of case studies in their curriculum and developed a better understanding of the concepts. These findings are compliant with the study conducted by Garcia et. al [7].

Contrastingly, 40% of students found cases studies to be challenging when practiced in an in-person learning environment. This concern is valid since case studies were devised for students to extend beyond the perimeters of their theoretical knowledge and seek for a creative solution to solve a challenging problem. Case studies can also be challenging to those students who already possess a weak foundation of the concepts at hand or include technical information which requires students to perform secondary research to obtain clarity.

Majority of the students perceived a neutral viewpoint towards feeling motivated and challenged, this may require additional guidance from the instructor, and having learned more with case studies. The implies that students were uncertain about the effects of CBL on their overall attitudes and learning experiences when in a virtual learning environment, as opposed to feeling confident about the effects of CBL when in an in-person environment. This is primarily due to the lack of full exposure to the ideal CBL delivery platform, which is intended to be in-person.

Comparing the results between both delivery platforms, students found the cases to be less challenging when practiced in a virtual environment with the opportunity to surf the internet to conduct extensive secondary research on the cases. Since remote learning facilitated instructors to record their presented lectures, students were also able to re-read the information taught in class to establish a better foundation of concepts they initially misinterpreted or found challenging.

Opposingly, students also experienced more frustration in the virtual classroom setting with not being able to engage with the instructor and peers face-to-face for a productive and an interactive classroom discussion, which cannot be replicated virtually. The frustration could also be a result of technical hindrances, leading to miscommunication. Hence, the lack of student engagement and realism are major factors which account for the disparities amongst both delivery platforms.

4. Conclusions

Case based learning is comparable to Bloom's Taxonomy of learning comprised of remembering, understanding, applying, analyzing, evaluating, and creating. The incorporation of CBL can aid educational institutions in preparing students for the industry by translating theoretical knowledge acquired in classrooms to dominate real-world

challenges. The narrative format of CBL enables students to immerse themselves into the cases, encouraging them to be more inductive reasoners.

The results obtained from this study prove that irrespective of the delivery format, CBL induced positive effects on the overall learning experience of students in undergraduate engineering technology education. CBL deemed a pivotal tool in helping problem solve, improve critical thinking skills, facilitate a deeper and conceptual understanding, and application, enhance self-confidence, and promote course performance.

The disparities in student opinions on CBL having a greater influence on student learning when delivered via an in-person classroom setting opposed to a virtual classroom setting is a result of unavoidable technical and diction challenges mentioned, causing the inability to replicate an in-person classroom extensively. Therefore, CBL was found to have a reduced impact on problem-solving, teamwork, communication skills, real-life technical skills and the learning experience of students who experienced CBL in a virtual format. The differences also imply that more students would benefit from the effects of CBL via its designated platform, i.e., in an in-person learning environment. This is evident due to virtual learners perceiving a neutral viewpoint on several statements in the survey conducted, experiencing ambiguity regarding the effects of CBL, owing to the lack of exposure to the optimal CBL environment.

This study also aimed to explore the student perceptions of two different graduating cohorts who completed the same course, belonging to the same undergraduate program to minimize variability while evaluating the two delivery formats. While students in the Fall 2021 division were previously accustomed to practicing CBL in-person, their opinions were insightful in understanding the transformations they underwent after adapting to a virtual CBL classroom setting. On the other hand, students in the Fall 2022 previously bore witness to in-person CBL during their initial years of studies, adapted to virtual CBL learning during the pandemic, and then retracted back to in-person CBL learning post-pandemic. Hence, the Fall 2022 cohort served as a more credible and valuable source to best distinguish amongst the two delivery formats after completing an imperforate academic experience with the platforms of CBL. The cohort was also beneficial in examining how students reformed back to in-person learning after following an exhaustive online-based learning system for nearly three academic semesters.

The findings demonstrate that a fraction of students in the Fall 2022 division disagreed with CBL developing their problem-solving, teamwork, real-life technical skills and improving learning experience, when in a virtual CBL learning environment. Opposingly, no students in the Fall 2021 division disagreed to these claims. This insinuates that the students in the Fall 2022 cohort were more conscious about the reduced effects of CBL, when practiced in a virtual setting. Additionally, they disagreed with CBL enhancing their self-confidence, when in an in-person CBL learning environment. This indicates that habituated with the virtual learning environment, it was challenging for the students to acclimatize back to the in-person classroom setting, to an environment where they previously felt confident to express themselves freely. Grooved with hiding behind the lens of their computer screens, lack of in-person group discussions, documenting answers independently using an online word processor, and procuring solutions to case studies in the blink of an eye are all contributors to this cause.

With educational institutions still determining whether to revert to an in-person classroom setting or offering a blended learning approach, it is essential to consider the findings of this study to create a better virtual learning experience for students in the future. In order to ensure active student participation, instructors can use online tools to monitor student attendance or perhaps, even offer bonus marks to encourage discussions. Students can be requested to turn their cameras on while engaging in discussions to recreate a sense of connection and community. Instructors can also assign roles to individual students within a group such as a facilitator, an arbitrator, and a notetaker to ensure the group is able to focus and stay on task. It is also essential that the instructor provide a safe and comfortable space for the students mentally, so they feel empowered to express their opinions freely and contribute to discussions.

Acknowledgments – The authors are grateful to the comments and suggestions from Dr. Clyde Freeman Herreid and Dr. Aman Yadav.

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