Guidelines for a vigorous on-line learning in a civil engineering programme

**Tahar Ayadat, Mohammad A. Khasawneh, Saidur R. Chowdhury, Layal Jradi,
Danish Ahmed, Samar Dernayka & Andi Asiz**

Prince Mohammad Bin Fahd University
Al Khobar, Kingdom of Saudi Arabia

ABSTRACT: The main objective of this study was to develop important guidelines and specifications for a vigorous and effective on-line learning specific to the civil engineering programme using a quantitative survey and analysis. A comprehensive survey was distributed during the spring semester 2021-2022 to civil engineering students at Prince Mohammad Bin Fahd University, Al Khobar, Kingdom of Saudi Arabia, with the primary purpose of establishing the main requirements and recommendations for an efficient and compelling on-line learning in the programme. This study aimed to point out the variables influencing the quality of on-line learning, including administrative support, course content, course design, instructor characteristics, learner characteristics, social support and technological support. Although the Covid-19 pandemic is nearly over and students are mostly back to the traditional face-to-face learning, the authors expect that the outcomes and recommendations from this study will complement existing virtual learning guidelines and will guide future educational policy makers developing hybrid learning that can optimise efficient on-line and face-to-face modes.

INTRODUCTION

During the Covid-19 pandemic, universities and other educational institutions have been compelled to shift from the face-to-face learning mode to virtual or on-line learning in nearly all disciplines [1-4]. There have been many recommendations provided by on-line educational experts on how to conduct on-line learning efficiently without compromising learning outcome achievements. Most of these recommendations were applicable to all disciplines with only few observed for particular engineering programmes [5-8]. The implementation of on-line learning specifically in civil engineering programmes has been relatively modest due to the diversity of the courses ranging from theories, engineering designs and experimental activities [9]. During the past two years, many educational practitioners have tried to tackle the effectiveness of the on-line learning process in their programmes through descriptive studies, primarily by conducting different kind of surveys distributed to students, faculty and educational administrators [10-13].

Ayadat revealed the reflections of Prince Mohammad Bin Fahd University (PMU), Al Khobar, Kingdom of Saudi Arabia's students at the end of the 2020 fall term concerning the effects of the virtual learning infrastructure and environment on the student learning [14]. The students agreed that the feature of replaying recorded lectures was one of the biggest benefits of the on-line learning, while the greatest difficulties were the poor Internet connection, distractions at home, lack of social support, on-line assessments and the intermittent communication with the instructor. Frida examined the status of on-line learning at the civil engineering programme in the University of Surabaya in Indonesia [15]. They recommended that the technological support is one of the most important factors that would enhance the on-line learning mode in delivering civil engineering courses. Asgari and Moskal also discussed the administrative and technological supports for on-line learning in civil engineering [16][17]. Both studies pointed out to a robust infrastructure for both students and faculty. One of the crucial strategies they proposed is about breaking down a long lecture into short sessions to keep students engaged.

Garcia-Alberti evaluated the status of on-line learning in a civil engineering programme in two universities in Spain and one university in Peru [18]. Students were asked about various aspects, like the assessments of the implemented evaluation methodology, usefulness of the virtual laboratory, instructor availability, course design, usage of innovative resources and interaction in virtual class. The results showed that it is essential to engage students further via animations and decrease their workload. In addition, taking further measures including the usage of digital tablets, implementation of pre-recorded videos and pre-set questionnaires and quizzes are recommended. Soeryanto conducted a study on mechanical engineering students' learning outcomes to analyse the effectiveness of the implementation of on-line learning during the Covid-19 pandemic [19]. They found that effective, efficient and innovative on-line learning improve students' learning outcomes significantly. Kyrkjebø provided a student guide for active on-line leaning in engineering [20]. The proposed guide emphasises the importance of social dynamics between students for successful group activities.

The on-line learning mode influences also the activities that require personal interaction, such as laboratories and design assignments. A study conducted in Poland points out on the strengths and weaknesses of on-line classes carried out during two semesters in the Faculty of Architecture at Wrocław University of Science and Technology (FA-WUST) [21]. An effective implementation of an on-line learning system requires certainly the development of resources, on-line platforms and other support systems. A survey conducted in Kazakhstan revealed that the majority of universities in this country have developed their own platforms or they are using other well-known platforms, such as Zoom or Teams, for an efficient interaction between students and instructors [22]. Several authors discuss the basic principles of an efficient distance learning which cover mainly the collaborative learning, adult learning and educational methodologies [23-26]. The authors recommend the development of a communication model that promotes critical thinking, enhances collaborative skills through proper methodological choices and technical means support, and includes a strong collaborative dimension [23-26].

The main objective of this study was to develop guidelines and specifications for a vigorous and effective on-line learning specific to civil engineering programmes using a quantitative survey and analysis. This study aimed to point out the variables influencing the quality of on-line learning, including administrative support, course content, course design, instructor characteristics, learner characteristics, social support and technological support. The authors expect that the outcomes of this study will complement the existing guidelines described above and guide further the implementation of the hybrid learning mode should certain circumstances allow it.

METHODOLOGY

The Department of Civil Engineering (CE) at PMU conducted a descriptive survey in order to establish the main requirements and recommendations for an efficient and compelling on-line learning in its programme, and moreover to point out the variables influencing the quality of on-line learning [27-30]. Respondents' perceptions, judgments and advice about their on-line learning experiences were systematically evaluated in the survey.

It was first necessary to identify the survey's objective, questions for research, target population, and sampling and data collection procedures before the questionnaire was developed. An appropriate expert reviewed and approved the survey instrument as reliable and valid. Data collection and administration of the survey were preceded by a pilot test.

Students' on-line learning experiences were investigated through the survey questionnaire analysis. The data were collected through a descriptive questionnaire prepared by faculty members in the CE Department. In the study, 120 undergraduate students enrolled in the PMU CE Bachelor of Science programme provided randomly sampled responses. This represented around 70% of response rate considering that the total number of CE students was 170. The items of the questionnaire were arranged in sequence into seven groups, including: administrative support, course content, course design, instructor characteristics, learner characteristics, technological support and social support. Each group was composed by three crucial or influential questions. Twenty-one (21) relevant and critical questions (Q1 to Q21) were adopted for the purpose of investigating the different elements, which might affect the on-line learning experience of the students, and to point out the variables influencing the quality of on-line learning. Furthermore, a question asking students to write comments regarding major benefits, major drawbacks, and suggestions for improvement were also provided in the survey (Q22).

Prior to its distribution, the questionnaire was elucidated and validated. It was validated to ensure its reliability. The face value of the survey was determined by experts. Pilot tests were also conducted with a subset of survey participants. The objectives and significance of the study was then discussed with CE students, and their voluntary involvement was requested. The survey was administered through the PMU Civil Engineering Club of the American Society of Civil Engineers (ASCE) to ensure confidentiality. Data were tabulated and analysed four weeks after the distribution of the questionnaire. Data were analysed using descriptive statistics, including percentage distribution, to determine the different variables of the study. A spreadsheet was used to clean the collected data.

The use of multiple data sources and research methods for understanding phenomena certainly has many advantages. Nevertheless, this study employed a descriptive research model that is considered conclusive due to its quantitative nature. As well as being reliable and prevalent, it is one of the most widely used research methods. Such research models are useful for better defining a group's opinion, attitude or behaviour on a particular subject. In addition to being adequate, valuable and representative, the sample of participants is also adequate. Aside from this, the methods of acquiring, storing and processing data have become more complicated and expensive due to the current Covid situation.

RESULTS AND DISCUSSION

As was discussed above, the primary purpose of this study was to identify the main requirements for an efficient and compelling on-line learning experience in a civil engineering programme, along with the main factors influencing its quality. The survey mentioned above was conducted to establish the main guidelines for a vigorous on-line learning with the aim of continuously improving the effectiveness of the virtual learning. An important consideration in evaluating on-line learning is assessing how students would have benefited from it. Should the current pandemic situation continue or if any similar situation occurs in the future, the shortcomings and suggestions provided by students will be applied to improving the virtual teaching modality at PMU.

In addition to tabulating and analysing the students' responses to the survey, the results of the survey were reported as well. Firstly, the different groups of questions were analysed separately to perceive and quantify students' answers and appreciations. Then, the comments assembled or collected from Q22 regarding major benefits, major drawbacks and suggestions for improvement were examined.

Administrative Support

A well-supported on-line education programme will require administrative support, such as funding, guidance, teaching programme improvement, oversight and assistance to remove obstacles that prevent improvement. To develop an effective learning environment, careful and purposeful processes must be followed including courseware design, technology selection, faculty and other staff skills development, and consideration of student workloads. It is believed that for an on-line programme to be successful, it must be well developed. In order to design courses that are effective, instructors need to understand that students have diverse preferred learning styles. Table 1 presents the students' responses (in percentages) concerning the teaching method, which should be followed in on-line learning. It is clear from Table 1 that students prefer to follow on-line classes or learn virtually in small groups ($\leq$ 5 students), or to a lesser extent, to conduct individual assignments.

Table 1: Results of students' response scores for Q1.

1. Which of the following methods do you personally prefer in virtual learning?		
1. Individual assignments	47	39%
2. Small group ($\leq$ 5 students) works	63	53%
3. Large group ($\geq$10 students) works	6	5%
4. Project-based learning	4	3%
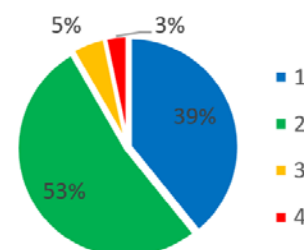
Learning and retaining information is the whole point of studying. The number of hours students will have to spend studying is one of the most common questions prospective students ask about in the programme department. It has been suggested over the years that a certain number of hours each student should spend studying depends on how difficult the class is and how efficiently they study. Table 2 shows the students' response scores about the number of credit hours that the students prefer to gain while learning virtually per semester at most. This table indicates that all scores are below 50%. However, it can be deduced from this table that the students almost prefer to take 12 to 15 credit hours per semester. The highest score of 39% was obtained for virtual learning of 15 credit hours, which represent an average of five different courses.

Table 2: Results of students' response scores for Q2.

2. How many credit hours do you personally prefer to gain in virtual learning per week at most?		
1. 9 credits	19	16%
2. 12 credits	32	27%
3. 15 credits	47	39%
4. 18 credits	22	18%
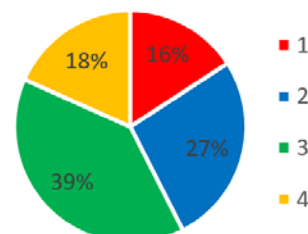
A variety of examination questions are used in universities as a means of assessment and evaluation, such as:

1) multiple choice;
2) true/false;
3) matching;
4) short answers;
5) essays;
6) oral;
7) computations.

Table 3 displays the students' feedback concerning the type of questions they prefer as a means of evaluation and examination. This table indicates that, except for the courses Materials in Civil Engineering, Engineering Geology, Environmental Engineering, and Water and Wastewater Treatment, seventy five percent (75%) of the students prefer essay questions in all remaining civil engineering courses listed in Table 3.

The students' response score is rational since the four courses listed above are predominantly theoretical courses, and the multiple-choice tests could be more appropriate. However, it is worthy to note that in the case of on-line leaning, this type of tests in not applicable and secure. The experienced in-place faculty members acclaim and endorse the adoption of essay question and problem solving in on-line examinations for all civil engineering courses listed in Table 3.

Table 3: Results of students' response scores for Q3.

3. In virtual learning, which courses require essay questions in evaluation methods; and which courses require multiple-choice tests (Please check only the courses which require essay questions)?		
Materials in Civil Engineering	47	39%
Structural Analysis	35	29%
Engineering Geology	45	38%
CAD for Civil Engineering	26	22%
Engineering Measurement	24	20%
Environmental Engineering	34	28%
Hydraulic Engineering	21	18%
Engineering Probability and Statistics	24	20%
Reinforced Concrete Design	10	8%
Sustainable Engineering	24	20%
Design of Steel Structures	10	8%
Introduction to Geotechnical Engineering	17	14%
Transportation Engineering	18	15%
Construction Management	18	15%
Foundation Analysis and Design	10	8%
Air Pollution and Control	29	24%
Water and Wastewater Treatment	32	27%

Course Content

Project-based learning involves students working on an authentic, engaging and complex question, problem or challenge for an extended period of time to gain knowledge and skills. Collaboration and group work are key components of project-based learning, which includes critical thinking, communication and creativity skills. According to the students' responses grouped in Table 4, the project-based teaching style can be applied in both modes of teaching (in person or on-line learning). A limited number of students are slightly more favourable and supportive in using this style of teaching in face-to-face learning.

Table 4: Results of students' response scores for Q4.

4. In which mode of teaching do you prefer project-based teaching style?		
1. In person	65	54%
2. On-line learning	55	46%
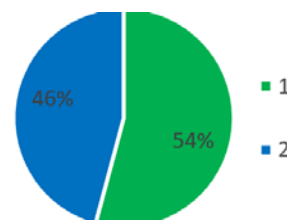
The term assignment refers to a piece of (academic) work or task. During this activity, students are given the opportunity to learn, practice and demonstrate that they have achieved learning goals. It serves as evidence for teachers that their students have accomplished their goals. Table 5 indicates that more than seventy percent (70%) of the students are positive and agreeable to use more assignments and homework in on-line teaching.

Table 5: Results of students' response scores for Q5.

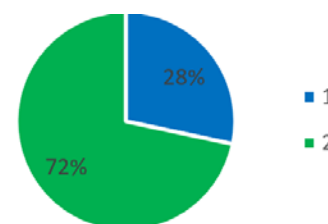| 5. In which mode of teaching do you prefer more assignments and homework?		
1. In person	34	28%
2. On-line learning	86	72%

Figure 6 shows the students' response score about the activities that are the most engaging in on-line learning. It is clear from this figure that the students prefer lecture and applications during their on-line learning. Lecture here can be defined as an oral presentation given by an instructor throughout the class session to convey information or teach students about a particular subject. During lectures, important information, history, background, theories and equations are presented to the students.

Table 6: Results of students' response scores for Q6.

6. What activities do you find most engaging in virtual classes?		
1. Lecture	48	40%
2. Applications	32	27%
3. Assignments/projects	23	19%
4. Videos	17	14%
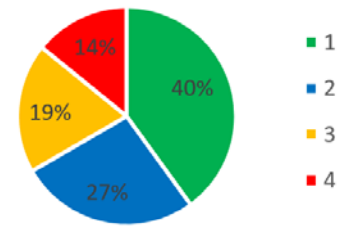
Course Design

Post Covid-19, most universities around the world have well-established infrastructure for offering courses either virtually or in person. This is advantageous and can offer good flexibility in course offering when special or unusual situations arise. Course design is an integral part of the learning and teaching process that must be fully addressed and clearly communicated with students. In this study, course design was assessed and evaluated in terms of mode of instruction and whether or not textbooks are imperative.

It is, therefore, of great importance to inspect students' perspective on which mode of course offering they prefer in order to set guidelines for a vigorous on-line learning in a civil engineering programme. That said, results shown in Table 7 and Table 8 revealed that in courses, such as Engineering Geology, Environmental Engineering, Engineering Probability and Statistics, Sustainability Engineering, Introduction to Geotechnical Engineering, Air Pollution and Control, and Water and Wastewater Treatment the on-line mode of teaching is preferred. The scores in percentages obtained for these courses for the on-line teaching mode are greater than 30%. Furthermore, all scores of these courses are higher than those recorded for the face-to-face teaching mode. In the other eleven courses shown in Table 7, students prefer the in-person teaching and learning mode. This could be attributed to the nature of the course content and the ease of applications and problem solving.

Table 7 and Table 8: Results of students' response scores for Q7 and Q8.

Which courses in the CE degree plan do you prefer to be conducted?				
	7. In person (face to face)		8. On-line	
Materials in Civil Engineering	50	42%	40	33%
Structural Analysis	53	44%	22	18%
Engineering Geology	24	20%	49	41%
CAD for Civil Engineering	56	47%	24	20%
Engineering Measurement	46	38%	36	30%
Environmental Engineering	21	18%	47	39%
Hydraulic Engineering	36	30%	31	26%
Engineering Probability and Statistics	30	25%	45	38%
Reinforced Concrete Design	38	32%	21	18%
Sustainable Engineering	18	15%	42	35%
Design of Steel Structures	45	38%	18	15%
Introduction to Geotechnical Engineering	26	22%	39	33%
Engineering Senior Design 1 and 2	39	33%	22	18%
Transportation Engineering	26	22%	29	24%
Construction Management	28	23%	25	21%
Foundation Analysis and Design	38	32%	20	17%
Air Pollution and Control	22	18%	36	30%
Water and Wastewater Treatment	27	23%	42	35%

Tables 9: Results of students' response scores for Q9.

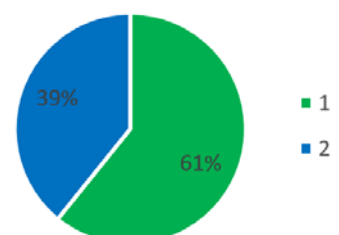| 9. In which mode of teaching the textbook is imperative?		
1. In person	73	61%
2. On-line learning	47	39%

Table 9, on the other hand, shows students' responses concerning the mode of teaching in which textbooks are imperative. It is clearly shown that 61% of the students think that the textbook is needed for the in-person mode of teaching and only 39% think that textbooks are needed and imperative when teaching is conducted virtually.

It is speculated that this observation is due to fact that in virtual classes or the on-line mode of learning instructors tend to provide more on-line materials, class notes and resources to make up for not being in direct contact with students. Most of the textbooks used in the programme are available on-line and can be linked directly to a learning management platform, such as Blackboard.

Instructor Characteristics

Instructor characteristics are equally important in the learning and teaching process. This factor was considered by incorporating questions in the survey, including the instructor aspects students prefer in a virtual learning environment, students' expectations from the instructor during a virtual class, and students' expectations from their instructor concerning the current tools used to conduct a virtual class.

The results have shown that regarding the instructor aspects students prefer in a virtual learning, the demonstration of enthusiasm and excitement about teaching the course is something that is well received and positively looked at by students (21%), followed by storytelling and linking real-world applications with theories being explained in the class (17%). Encouraging participation and asking questions during the class received the lowest preference among students (6%). Overall, 56% of the students supported all the above aspects be practiced by instructors as shown in Table 10. This result was anticipated because if teachers show passion in teaching, this passion will be transmissible to everyone in the classroom.

Tables 10: Results of students' response scores for Q10.

10. Which of the following instructor aspects do you prefer personally in virtual learning?		
1. Demonstrate enthusiasm and excitement about teaching the course	25	21%
2. Tell stories about what he is doing/explaining in class	21	17%
3. Encourage students to participate during class and spend time asking questions that empower participants	7	6%
4. All of the above	67	56%
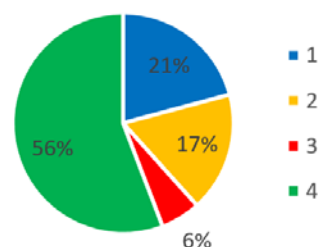
As far as students' expectations from instructors during a virtual class are concerned (Table 11), 33% of the students expected periodic checks by the instructor to see their progress. Sixteen percent expected conducting formal or informal surveys to assess attitude, workload and challenges faced by students, and only 8% expected *ad hoc* quizzes to ensure comprehension of the material. These results can be explained by students' immense care about their learning experience and best educational earnings.

Tables 11: Results of students' response scores for Q11.

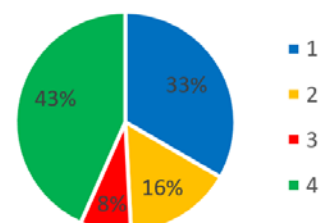| 11. What do you expect from the instructor during a virtual class?		
1. To check in regularly with students to see how things are going	40	33%
2. To do formal or informal surveys to assess attitudes, workload and challenges	19	16%
3. To use *ad hoc* quizzes to assess learner comprehension of material	9	8%
4. All of the above	52	43%

Table 12 presents students' expectations from their instructors considering the current tools used to conduct the virtual classes. It is clearly presented in the table that recording the virtual sessions is the most expected act from instructors (27%). This is reasonable since it allows students multiple chances to go back to the recordings and re-watch the lecture and use as a studying material for different upcoming class activities. Comparatively, only 3-8% of the students expected the other three items presented in Table 12, and 57% expected the four items altogether.

Tables 12: Results of students' response scores for Q12.

| 12. Concerning the current tools used to conduct the virtual classes, what do you expect from your instructor?		
1. Recording the virtual sessions (lectures, tutorials, etc)	32	27%
2. Regularly check all links, resources, modules and activities	6	5%
3. Assist students who are having difficulty navigating course links	10	8%
4. Demonstrate how to appropriately manage keeping track of navigation	4	3%
5. All of the above	68	57%
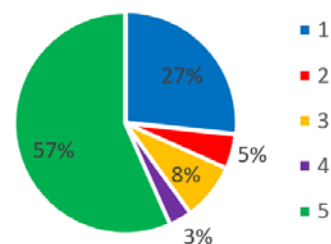
Learner Characteristics

The results obtained showed that only 7.5% of the students believed that to be successful in on-line learning the student should be persistent, and 11% of them admitted seeking help when needed. However, 66% of the students believed all items listed in Table 13 were important characteristics for learners in order to attain benefits from virtual sessions. Accordingly, the students should be persistent, tolerate technical problems, seek help when needed, and work daily on every class and persist through challenges. This finding or observation was received and accepted by the experienced in-place faculty members. Students who pursue education on-line must be motivated, committed, prepared and proactive. Persistence, organisation and engagement can enhance students' learning capacity. Aspiration and persistence are also required to achieve maximum academic success. Satisfactory on-line students can develop techniques to stay involved and interested in their on-line course. The present study aimed to establish ways in which authorities can increase the efficiency of students from current teaching and learning processes.

Tables 13: Results of students' response scores for Q13.

13. To be successful in virtual learning, the student should be:		
1. Persistent	9	7.5%
2. Tolerate technical problems	9	7.5%
3. Seek help when needed	13	11%
4. Work daily on every class and persist through challenges	10	8%
5. All of the above	79	66%
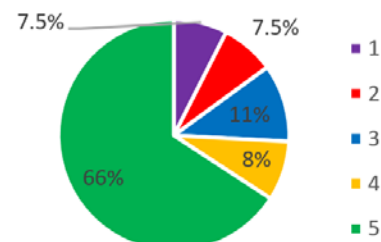
In Table 14, 26% of the students believed that independent, motivated, determined to succeed and responsible learners to be more successful in virtual learning. Whereas, 66% of the students agreed that to become a successful learner, one must possess all the characteristics that were included in Table 14 and listed below. Through effective communication, students can control their own learning environment and strategies to complete course requirements, and achieve individual academic achievement.

Tables 14: Results of students' response scores for Q14.

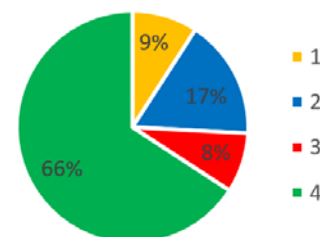| 14. To be successful in virtual learning, it is required from the student to be:		
1. Determined to succeed	11	9%
2. Independent, internally motivated and responsible	20	17%
3. Has a certain level of maturity	10	8%
4. All of the above	79	66%

Table 15 shows different levels of communication of students with their instructors. The results show that 17% of the students supported the second criterion or statement, which is about the learner's involvement with the instructor regarding the perception and understanding level of course materials. Attention to e-mails and course announcements by the instructor obtained 13% of the students' responses. Similarly, 59% of the students said that all of the traits listed in Table 15 were necessary for someone to be a successful learner. Successful on-line students must be self-disciplined and goal-oriented to complete successfully their tasks, read all e-mails and announcement in time, understand the course materials and ensure they ask questions they have. Successful on-line learners are aware that their instructors are facilitators of their learning process and that each individual learner must be a committed self-starter with clear goals.

Tables 15: Results of students' response scores for Q15.

| 15. In virtual learning, communication with the instructor is the most important factor. Consequently, the student should:		
1. Read and pay close attention to his e-mails and course announcements	16	13%
2. Keep his instructor informed of his learning situation and make sure he asks all the questions he has	20	17%
3. Take advantage of his instructor's virtual (or in person) office hours	13	11%
4. All of the above	71	59%
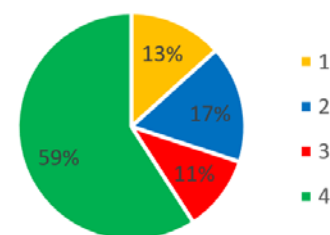
Technology Support

Table 16 to Table 18 show the results of the investigation of technological support based on student opinion. The results grouped in Table 16 indicate that around 70% of the students are more motivated to learn, when a PowerPoint presentation or whiteboard and pen is used to share the necessary information and lectures during a virtual lesson. In addition to the list highlighted in Table 16, video conferencing platforms could be popular that allow screen sharing permitting users to annotate any on-screen material, and one may set up a shared whiteboard for students to collaborate on problem solving.

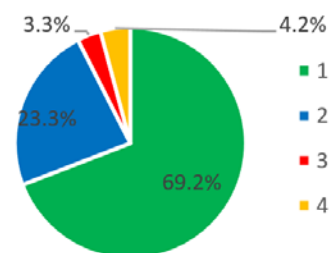Tables 16: Results of students' response scores for Q16.

16. Which of the following virtual approaches motivate the student to learn?		
1. Animations	16	13%
2. Whiteboard and pen	41	34%
3. PowerPoint presentation	42	35%
4. Digital pen and slate	21	18%
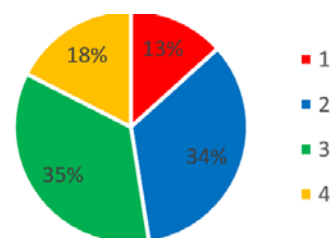
From Table 17, it is clear that students prefer a laptop and a desktop (about 69%) for participating in or facilitating interaction in virtual lessons. Furthermore, according to the results summarised in Table 18, 33% of the survey respondents strongly agree that a stable and reliable Internet connection is required for smooth virtual lessons. It is likely that the transition to more varied and interactive learning models will continue. The present study can explore the best options from learner opinion regarding technical support necessary to conduct more interactive virtual lesson. Lessons become more engaging and entertaining when technology is used properly, which allows each student additional opportunities to actively participate with their subject matter.
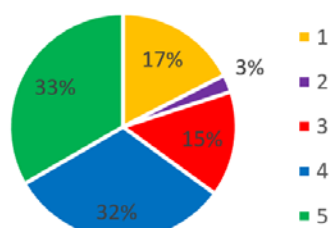
Tables 17: Results of students' response scores for Q17.

17. Which of the following devices do you prefer for your virtual learning?		
1. Laptop/desktop computer	83	69.2%
2. Tablet	28	23.3%
3. Smartphone	4	3.3%
4. Other devices	5	4.2%

Tables 18: Results of students' response scores for Q18.

| 18. To be successful in virtual learning, the student should have a stable and reliable Internet connection.		
1. Strongly disagree	21	17%
2. Disagree	3	3%
3. Neutral	18	15%
4. Agree	38	32%
5. Strongly agree	40	33%

Social Support

Likewise, the social support is one of the most important parameters that influence the quality of virtual learning. For this reason, a measurement of the impact of social support on on-line learning was carried out using a questionnaire that consists of three main questions.

The first question aimed to investigate the students' needs in order to be successful in a virtual learning environment. Table 19 presents the results of students' responses. It is obvious that the majority of the students (56.7%) agreed that all the listed needs are essential for them. Therefore, based on these results, it is clear that students need to work in a quiet environment, turn off their cell phones during virtual learning, set up good lighting and uninstall any games that could cause disruptions to them during their learning session.

Tables 19: Results of students' response scores for Q19.

19. To be successful in virtual learning, the student needs:		
1. A quiet place to work without distractions from things like television, family or roommates	39	32.5%
2. Consider uninstalling any computer games to avoid temptation or to keep the games on a different computer in the house	4	3.3%
3. Turn off his cell phones	3	2.5%
4. Set up good lighting and comfortable seating	6	5.0%
5. All of the above	68	56.7%
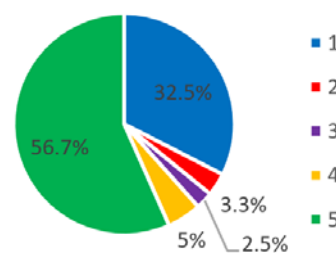
The second question intended to investigate the preferable situation at the place of students' residence during their virtual learning. The results are shown in Table 20, where 50% of the students agreed that having a moderate amount of responsibilities best suits them in order to succeed in their on-line learning.

Tables 20: Results of students' response scores for Q20.

20. At the place of residence and during his virtual learning, the student should:		
1. Not have many responsibilities	39	32%
2. Have a moderate amount of responsibilities	60	50%
3. Have many responsibilities	21	18%
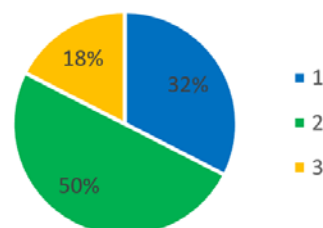
The third question intended to investigate the influence of the students' surrounding on their virtual learning. As shown in Table 21, it is obvious that the majority of the students (75%) agreed that no one should disturb them during their on-line learning.

Tables 21: Results of students' response scores for Q21.

21. Which of the following statements is true of virtual learning off-campus?		
1. No one should disturb me during my on-line learning	90	75%
2. My friend/family member/roommate/neighbor can occasionally disturb me	20	17%
3. My friend/family member/roommate/neighbor can constantly disturb me	10	8%
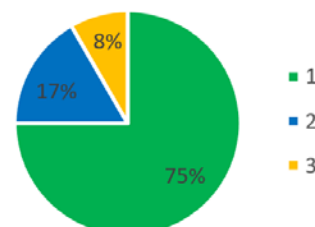
Student Additional Comments

All the comments addressed by the students in question Q22, i.e. additional comments concerning the guidelines of rigorous on-line learning, were collected and analysed. The main students' observations obtained from this study are summarised as follows:

1. Instructors should motivate students in their on-line classes.
2. Lectures should be recorded.
3. Students should adopt a learner's mindset in order to gain knowledge and remember it in the long run.
4. Students should stay away for disturbing means, such as children, television, etc.
5. Instructors should be tolerant with students' circumstances during on-line learning.
6. Quizzes and examinations should be conducted in person (face-to-face).
7. Some classes must be conducted in person, such as AutoCAD drawing and Laboratory.
8. In order to motivate students further, more activities should be included in on-line learning (such video sessions, practical applications, etc).
9. Internet connection should be stable and the learning environment should be healthy.

The comments above are mostly in agreement with the observations made by students analysed by Ayadat [14].

CONCLUSIONS AND RECOMMENDATIONS

During the Covid-19 pandemic, educational practitioners have experienced utilising the on-line learning mode to deliver courses with mixed results. It has been demonstrated by several educators that efficient on-line teaching delivery can make students achieve learning outcomes as that of the traditional face-to-face mode. Although the pandemic is nearly over, the on-line learning mode can still be used under certain circumstances, and potentially practiced in combination with the traditional learning mode as a hybrid approach.

The following are the main requirements and recommendations for efficient and compelling on-line learning in a civil engineering programme based on the present study:

1. Students prefer to learn virtually in small groups (≤ 5 students). They almost prefer to take 12 to 15 credit hours per semester. They prefer essay-type questions in all civil engineering courses, except Materials in Civil Engineering, Geology Engineering, Environmental Engineering, and Water and Wastewater Treatment.
2. Project-based learning can be incorporated into the on-line mode. Students are positive and agreeable to use more assignments and homework in on-line teaching. They prefer lectures and theoretical applications (design) as the teaching style during on-line learning.
3. The civil engineering programme can technically deliver all courses on-line. However, some courses with theoretically oriented content are preferred on-line. The textbooks are not imperative in the on-line mode.
4. Students prefer the instructor who demonstrates enthusiasm and excitement about teaching the course. They anticipate periodic checks by the instructor to see their learning progress. Furthermore, they expect from the instructor to record the virtual sessions (lectures, tutorials, etc), and to regularly check all links, resources, modules and activities. Students also expect the instructor to assist if/when they are having difficulty navigating course link.
5. Students should be persistent, tolerate technical problems, seek help when needed, work daily on every class, persist through challenges, determined to succeed, independent, internally motivated, responsible and have a certain level of maturity. Moreover, they should read and pay close attention to their e-mails and course announcements, keep the instructor informed of their learning situation and make sure they ask all the questions they have, and take advantage of their instructor's virtual office hours.
6. Students prefer using PowerPoint presentations or a whiteboard with pen to share the necessary lecture information during a virtual lesson. They prefer using laptops and desktops in virtual lessons. They agree that a stable and reliable Internet connection is paramount for smooth virtual lessons.
7. Students need a quiet place to learn on-line without distractions, consider uninstalling any computer games and any unnecessary software distractions, turn off cell phones, and setup good lighting and comfortable seating. Furthermore, they prefer to have a moderate amount of responsibilities in order to succeed in their on-line learning, and no one should disturb them during this activity.

ACKNOWLEDGMENTS

REFERENCES

1. Ghasem, N. and Ghannam, M., Challenges, benefits & drawbacks of chemical engineering on-line teaching during Covid-19 pandemic. *Education for Chemical Engineers*, 36, 107-114 (2021).
2. Mushtaha, E., Dabous, S.A., Alsyouf, I., Ahmed, A. and Abdraboh, N.R., The challenges and opportunities of online learning and teaching at engineering and theoretical colleges during the pandemic. *Ain Shams Engng., J.*, 13, **6**, 101770 (2022).
3. Muthuprasad, T., Aiswarya, S., Aditya, K.S. and Jha, G.K., Students' perception and preference for online education in India during COVID -19 pandemic. *Social Sciences & Humanities Open*, 3, **1**, 100101 (2021).

4. Grodotzki, J., Upadhya, S. and Tekkaya, A.E., Engineering education amid a global pandemic. *Advances in Industrial and Manufacturing Engng.*, 3, 100058 (2021).

5. Abelskamp, G. and Santamarina, J.C., Academia during the Covid-19 pandemic: a study within the geotechnical engineering research community. *Inter. J. for Innov. Educ. and Research*, Dhaka, Bangladesh, 9, **1**, 574-587 (2021).

6. Alkabaa, A.S., Effectiveness of using e-learning systems during COVID-19 in Saudi Arabia: experiences and perceptions analysis of engineering students. *Educ. and Infor. Technol.,* 27, **8**, 10625-10645 (2022).

7. Sunardiyo, S., Online learning in higher education during the Covid-19 pandemic: a case study in the Department of Electrical Engineering, Universitas Negeri Semarang. *Proc. IOP Conf. Series: Earth and Environmental Science,* 700, **1**, 012020 (2021).

8. Ong, A.K.S., Prasetyo, Y.T., Young, M.N., Diaz, J.F.T., Chuenyindee, T., Kusonwattana, P., Yuduang, N., Nadlifatin, R. and Redi, A.A.N.P., Students' preference analysis on online learning attributes in industrial engineering education during the COVID-19 pandemic: a conjoint analysis approach for sustainable industrial engineers. *Sustainability*, 13, **15**, 8339 (2021).

9. Maraqa, M.A., Hamouda, M., El-Hassan, H., El Dieb, A.S. and Hassan, A.A., Transitioning to online learning amid Covid-19: perspectives in a civil engineering program. *Online Learning J.*, 26, **3** (2022).

10. Churi, P., Mistry, K., Asad, M.M., Dhiman, G., Soni, M. and Kose, U., Online learning in COVID-19 pandemic: an empirical study of Indian and Turkish higher education institutions. *World J. of Engng.*, 19, **1**, 58-71 (2022).

11. Deepika, M. and Pushpa, J., Impact and perception of students towards online learning during COVID-19. *Asian J. of Agricultural Extension, Economics & Sociology*, 40, **10**, 26-32 (2022).

12. Matsouka, M., Valasidou, A. and Dagdilellis, V., Online teaching in the age of Covid-19: a case study at the Merchant Marine Academy's Engineering School of Macedonia, Seated in NeaMichaniona. *European J. of Engng. and Technol. Research*, 9-13 (2022).

13. Hafeez, M., Kazmi, Q.A. and Tahira, F., Challenges faced by the teachers and students in online learning during COVID-19. *J. Cakrawala Pendidikan, [S.l.],* 41, **1**, 55-70 (2021).

14. Ayadat, T., Khasawneh, M.A., Chowdhury, S.R., Nayeemuddin, M., Ahmed, D. and Asiz, A., Effects of students' home environment, tools, and technology used on online learning experience in a civil engineering program. *Inter. J. of Infor. and Educ. Technol.*, 11, **8**, 356-367 (2021).

15. Pakpahan, N.F.D.B., Effectiveness of online learning models for student understanding of subjects in the civil engineering department. *Inter. J. of Multicultural and Multireligious Understanding,* 8, **12**, 426-238 (2021).

16. Asgari, S., Trajkovic, J., Rahmani, M., Zhang. W., Lo, R.C. and Sciortino, A., An observational study of engineering online education during the COVID-19 pandemic. *PLoS ONE,* 16, **4**, e0250041 (2021).

17. Moskal, P., Dziuban, C. and Hatman, J., Blended learning: a dangerous idea? *The Internet and Higher Educ.,* 18, 15-23 (2013).

18. García-Alberti, M., Suárez, F., Chiyón, I. and Feijoo, J.C.M., Challenges and experiences of online evaluation in courses of civil engineering during the lockdown learning due to the COVID-19 pandemic. *Educ. Science,* 11, **2**, 59 (2021).

19. Soeryanto, Arsana, I.M., Warju, and Ariyanto, S.R., Implementation of online learning during the Covid-19 pandemic in higher education. *Proc. 3rd Inter. Conf. on Social Sciences,* 632-636 (2020).

20. Kyrkjebø, E., A guide to student-active online learning in engineering. *Modeling, Identification and Control*, 41, **2** (2020).

21. Brzezicki, M., Strengths and weaknesses of architectural education on-line classes conducted during COVID-19. *World Trans. on Engng. and Technol. Educ.,* 18, **4**, 381-386 (2020).

22. Rakhmetov, M., Sadvakassova, A., Saltanova, G. and Yessekenova, A., Usage and effectiveness of educational platforms in Kazakhstan during the Covid-19 pandemic. *World Trans. on Engng. and Technol. Educ.*, 20, **3**, 226-231 (2022).

23. Anastasiadis, P., and Metaxas, G., Issues of importance in engineering education and distance learning. *World Trans. on Engng. and Technol. Educ.*, 5, **3**, 393-396 (2006).

24. Siagian, S., Sinambela, N.J.M. and Wau, Y., Effectiveness and efficiency of e-learning in Instructional Design. *World Trans. on Engng. and Technol. Educ.*, 18, **1**, 73-77 (2020).

25. Bosman, L.B., McDonald, W. and Paterson, K., A collaborative multi-faculty approach to increase engineering competency through on-line discussions. *World Trans. on Engng. and Technol. Educ.*, 17, **2**, 152-157 (2019).

26. Simelane-Mnisi, S., Evaluating the quality of on-line modules in higher education. *World Trans. on Engng. and Technol. Educ.*, 20, **4**, 264-271 (2022).

27. Almahasees, Z., Mohsen, K. and Amin, M.O., Faculty's and students' perceptions of online learning during COVID-19. *Frontiers in Educ.*, 6, 638470 (2021).

28. Al-Nasa'h, M., Al-Tarawneh, L., Awwad, F.M.A. and Ahmad, I., Estimating students' online learning satisfaction during COVID-19: a discriminant analysis. *Heliyon*, 7, **12**, e08544 (2021).

29. Curelaru, M., Curelaru, V. and Cristea, M., Students' perceptions of online learning during COVID-19 pandemic: a qualitative approach. *Sustainability,* 14, **13**, 8138 (2022).

30. Arif, M.T. and Shafiullah, G., Exploring teaching and learning experience during COVID-19 pandemic in engineering education. *Sustainability.*; 14, **12**, 7501 (2022).