

Engineering student experiences of a remotely accessed, online learning environment

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Abstract—This study explores engineering student experiences of the emergency, remote online teaching and learning environment initiated due to the COVID-19 pandemic. The study uses a Likert scale survey based on the Community of Inquiry model evaluating Social, Teacher, Learner, and Cognitive presence in the online environment. Insights are provided relating to the design of the teaching and learning environment, student behaviours, assessment, social learning and how students cope in this mode. The results from this study can be used to better understand how students experience this environment, informing design and integration in similar interventions in the future.

Index Terms—online learning, community of inquiry, learning presence, teacher presence, social presence

I. INTRODUCTION

New technologies provide increasing opportunities to challenge traditional teaching and learning in Higher Education [1]. Online learning environments, in particular, have the potential to broaden access to higher education [2]–[4] and to align university teaching with the lifelong learning of contemporary professionals [5]. Many would argue that the shift to online teaching and learning environments is not only inevitable but an imperative to align graduate competencies with evolving workplaces [6], to ensure that higher education is sustainable into the future and facilitates collaboration between institutions, [7]. Online learning environments, however, need to be designed differently and cannot merely be a replication of traditional learning environments in an online space [1]. There is also still uncertainty regarding how easily students can adapt to these changes and whether online environments can adequately facilitate the development and attainment of the intended outcomes and graduate attributes.

For many higher education institutions in South Africa and across the world, the COVID-19 pandemic has resulted in a sudden move from traditional teaching and learning

to the online environment. For the university used in this study, teaching and learning changed from a blended learning approach incorporating face-to-face and online elements to a fully online-dependent and remote model. This study was motivated by these circumstances which provided an opportunity to explore student's experiences of this process and their learning behaviours as they interact with this emergency, remote, online [8] learning environment. There is currently limited literature that specifically explores how students experience this unique circumstance and Jeffery & Bauer [9] have shown how understanding the student experience can provide insights for all teaching and learning environments. As a consequence, the research question for this study was: How do students experience teaching and learning in an emergency, remote, online learning environment?

The aim of this study is that the findings can provide insights for the design of online teaching and learning environments in general and can inform similar, future interventions. Furthermore, although the circumstances around the abrupt introduction of online learning is likely to influence results, valuable data can be gained regarding online learning more broadly. Current thinking suggests that the move to online learning as a result of the COVID-19 pandemic will forever change teaching and learning environments and that the future of higher education is likely to see a more rapid introduction of hybrid, online and remote experiences. The findings can therefore also be used to highlight challenges experienced by students and the intended and unintended consequences of online and remote learning environments.

II. LITERATURE REVIEW

Higher-order thinking is a requirement for any learning in a higher education context. Garrison et al. [10] state that a critical community of inquiry is essential to facilitate and encourage this higher-order thinking through a collaborative

and reflective learning experience. This experience needs to create opportunities for students to critically analyse subject material by questioning and challenging what is presented and then using this process to re(construct) knowledge by relating the material to experiences. The Community of Inquiry (COI) model [10] recognises three essential elements for a successful online learning experience: the cognitive, social, and teaching presence. Cognitive presence relates to thinking and involves the ability of students to construct meaning through reflection and communication. Social presence involves the personal and emotional connection to the group and the ability of students to project themselves as “real people” [10]. Teaching presence represents the course facilitator, who directs the cognitive and social processes and provides feedback to students.

Shea & Bidjerano [11] have identified a fourth presence that they believe completes the Community of Inquiry model. This additional presence, the learning presence, refers to the self-direction skills that are required to identify and operate in the learning context. They propose that online learning environments rely more heavily on self-directed learning skills than face-to-face learning environments. Students often lack important self-regulating skills, particularly when exposed to online learning for the first time. Pool et al. [12] have found that if the self-regulation skills of students are underdeveloped, this affects teacher presence as additional guidance, scaffolding and support needs to be provided as students navigate the new territory.

Several studies have explored how students experience online learning environments. It has been found that many challenges and opportunities exist and that understanding these can result in improved design and use that can sustain and even enhance student learning. Many of the challenges of online learning stem from practices and expectations developed in traditional learning contexts. These include lack of pacing and direction facilitated by weekly class schedules and lecturer-centred teaching approaches [1]. Bourne et al. [7] however, argue that it is the underlying pedagogy and design of the teaching and learning environment that determine these factors and that online learning can involve high levels of communication and instructor engagement resulting in a people-oriented learning solution. Online environments do however, initiate a change in the skills required by students. Students need to be more adept at using technology [13], which can alienate students who are apprehensive or have an aversion to using it [14]. Engaging in these environments, depending on their design, can also require students to be more proficient in written communication [13].

The impact of an online environment on students should be understood by teachers so that they can provide opportunities for students to expand and develop their skills and engage more meaningfully [7]. This includes self-directed learning skills [1], which are linked to independent learning competencies (a graduate attribute required by accrediting bodies) and the creation of engineering entrepreneurs and innovators [15]. A key feature of the online learning environment is the learning community that is created. Communities are relatively informal, flexible, and collaborative spaces that form

around a common objective through a series of interactions and exchanges [16]. Online communities have the potential to create more equal and accessible spaces and can increase the ability of students to personalise their learning experiences [1], enhancing independence and agency and improving students’ attitudes towards their learning [13].

III. METHOD

A. Study context

This study took place in the Faculty of Engineering at the North-West University in South Africa. This Faculty consists of several engineering disciplines located in four Schools. The Engineering Council of South Africa (ECSA), the accrediting body, plays an influential role in degree outcomes and internal processes development to ensure that students meet these outcomes. In general, teaching and learning in the Faculty is facilitated through a combination of face-to-face and online components. Class sizes vary depending on the year of study and the chosen discipline. Some modules are also shared across disciplines resulting in larger class sizes and opportunities for multi-disciplinary interaction. The University makes use of a customised Learning Management System (LMS) that incorporates functionality for teaching material and content, formative assessment and collaboration and interaction between students and lecturers and between students in the class. Adoption of the LMS to enhance teaching and learning varies significantly between modules with some modules making little to no use of the LMS and other modules making extensive use of a wide variety of tools in a blended learning environment. All students and staff have access to support for the LMS through several avenues. The face-to-face component of teaching and learning includes lectures from faculty staff and industry experts, tutorials, laboratory activities and experiential learning through interaction with industry and the broader community. Assessments for many modules are traditional sit-down tests and exams but can include a variety of project and portfolio work. As a result of the COVID-19 pandemic, the Faculty developed a strategy to continue the first semester of teaching and learning in an emergency, remote online learning mode. Interventions aimed to give as many students as possible access to devices and data and the LMS and other associated software portals were given zero-data ratings so that students could interact on these platforms without any additional costs. Lecturers were required to place all learning material on the LMS and were encouraged to make use of the tools in the LMS to get students to engage with the material, classmates and the lecturers. Formal, end-of-semester exams were replaced with continuous online assessment throughout the semester. A decision was made to favour the asynchronous teaching and learning mode to reduce pressure on students who had limited access. The implementation of the Faculty’s strategy for the emergency, remote online mode was not entirely smooth and many issues were encountered by staff and students along the way.

B. Research instrument design and data collection

An online student survey was developed for this study, using the Community of Inquiry Model [10], [11] as the underlying framework. The survey included a total of 44 questions and statements, divided into three main sections. The first section included demographic questions related to the year and discipline of study, quality of internet access, and the physical study environment. The second section explored student experiences, addressed through the four presences of the theoretical framework. A section also considered student experiences of assessment. The statements in this second section were collated and randomised and were not categorised according to the presences or assessment and used a four-point Likert scale, including the categories of strongly agree (1), agree (2), disagree (3) and strongly disagree (4). The third section provided an opportunity for students to discuss their experiences and challenges in their own words by answering three open-ended questions. Ethics clearance was obtained for the study, and ethical principles were adhered to throughout the study. Using SurveyMonkey, online questionnaires were distributed to all undergraduate students (n= 1447 students) in the Faculty in late July 2020. This sampling period coincided with the end of the first teaching semester for the students.

C. Analysis

The data from the Likert scale section of the survey were analysed using simple descriptive statistics [17] including percentage strongly agree/agree, loading factor, the mean (μ) and standard deviation (σ) for any statement. An exploratory factor analysis using principal component analysis was also performed on the student responses to identify emergent themes and consistency between responses [18]. Negative loading factors, identified during execution of the factor analysis, were sign-reversed to align positively and negatively phrased statements. These statistics were interpreted by comparing the results to the literature that supports the theoretical concepts for this study. Internal consistency between statements within a factor was measured using Cronbach's Alpha and mean inter-term correlations as appropriate. The qualitative data revealed rich findings that will be presented in another paper; however findings are used to support the overall argument for this paper where appropriate.

IV. RESULTS

A. Demographic considerations

1) *Respondent profile*: Responses were received from 558 students with a distribution between Schools that corresponds with the enrolled students per School. The percentage split across years of study was: 26% in first year, 25% in second year, 29% in third year and 20% in fourth year.

2) *Quality of internet access*: Of primary importance for internet teaching and learning is access through the internet and a suitable device. Respondents indicated that 91.0% had access to a computer (7.0% to a shared computer) and 85.1% had access to a mobile device (3.4% to a shared mobile device). The combined access to a computer and mobile

device is important as students often had to use a mobile phone to set up a hotspot if they wanted to make use of zero-rated data. The responses regarding access to data are shown in Table I. The students could choose more than one option therefore, the total is greater than 100%. For students who did not have sufficient available data, 8.8% indicated that the zero-rating of data provided a solution while 5.4% indicated that it did not.

TABLE I
ACCESS TO DATA

Statement	%
I had unlimited (uncapped) data available	45.3
I had sufficient (capped) data available	34.8
I had to purchase data but had sufficient funds	13.4

For online teaching and learning to be successful, in addition to access to the internet, it is also important to explore the stability and speed of the internet connection. Responses to selected statements regarding internet access quality are shown in Table II. The Cronbach Alpha for this group was 0.874, indicating high internal consistency between the statements. In general, respondents indicated that they did not have serious internet problems. However, almost a third of the respondents indicated that their internet connection was unreliable and unstable, and 15% of respondents felt that they were hampered by their inability to access the internet. This suggests that it is necessary to make provision for interruptions in internet access and that synchronous, online modes may present problems for a significant number of students. Students may also experience problems with submitting tests and assignments within narrow time frames, a theme that also emerged in the open-ended responses.

TABLE II
INTERNET ACCESS AND QUALITY

Statement	Strongly Agree Agree (%)	μ	σ
The internet connection was unreliable and unstable	32.9	2.73	0.813
The internet was often unavailable when I had to submit assessments	29.4	2.86	0.789
My internet connection was sufficiently fast	74.1	2.15	0.734
My ability to study was hampered by my inability to access the internet	14.8	3.19	0.730

3) *Physical Environment*: For effective learning, students should also have a conducive physical environment; selected responses are shown in Table III. The Cronbach Alpha for this group was 0.84, indicating high internal consistency between the statements. In general, respondents agreed that they had a physical environment conducive to learning. While 54.3% of respondents indicated that they were distracted while studying. This phenomenon may not be specific to the emergency, remote online circumstances and could also be prevalent during an ordinary academic year. The difference is that under ordinary circumstances, students are more likely to have alternative options.

TABLE III
PHYSICAL ENVIRONMENT

Statement	Strongly Agree Agree (%)	μ	σ
My physical environment was conducive for my studies	85.0	1.83	0.735
My study area was quiet	69.8	2.12	0.840
I was often distracted while studying	54.3	2.37	0.844

B. Student's experience of the online teaching and learning environment

An analysis of the statements pertaining to the COI model and assessment used five factors that resulted in minimal cross-loading and in factors that were consistent with our expectations based on literature. The Kaiser-Meyer-Olkin Measure of sampling adequacy was 0.932, above the recommended value of 0.8 [18]. The five factors that emerged related to teaching and learning design, learning behaviours, social interaction, challenges, and assessment. The first three factors relate to teaching, learning, and social presences in the COI model. While statements were formulated to measure the cognitive presence, this did not emerge as a separate factor in the analysis.

1) *Teaching and learning design Factor*: The factor that emerged with the highest number of statements relates to the design of the teaching and learning environment. The results are shown in Table IV with a corresponding Cronbach Alpha for this factor of 0.9, indicating a very high level of internal consistency.

The factor average of 2.08 suggests that the respondents agreed that the design of the teaching and learning environment supported their learning experience with many of these statements correlating strongly with teacher presence. The statements that received the lowest strongly agree/agree percentages correspond to the perceived support received from lecturers through guidance, feedback, and approachability. The mode of providing support is very different in an online environment compared to a face-to-face environment and this suggests that a change in approach may be necessary. This was confirmed in the qualitative data where many students indicated that accessibility to lecturers was a challenge. However, several students in the open-ended questions explained how they found lecturers to be "more present" in the online mode. Interestingly, the question with the highest strongly agree/agree response rate relates to the cognitive presence where 89% of respondents indicated that assessments challenged them to reflect critically on the material that was provided. It is also worth noting that this question loaded into this factor and not the assessment factor, perhaps suggesting the important role that assessment plays in overall teaching and learning design.

2) *Learning behaviour Factor*: Six statements loaded into a factor that concerns the ability of students to display effective learning behaviours in the online environment. These are included in Table V with a Cronbach Alpha of 0.773

indicating a high level of internal consistency.

These statements correlate strongly with learning presence in the COI model. The factor average of 1.9 indicates that most respondents felt that they were able to function successfully in the online environment suggesting appropriately developed self-directed learning skills. Interestingly, 37.4% of respondents indicated that they did not like working alone, linking to the importance of social interaction in the learning process.

3) *Social interaction Factor*: Social presence is a characteristic of good online teaching - the perception of students that they are "real persons" in the online environment. Three statements, shown in Table VI, loaded into this factor, which resembled the concept of social presence with a Cronbach Alpha of 0.636.

For factors with few statements, it may be better to use the mean inter-term correlation (MITC) to indicate internal consistency [19]. For this factor, the MITC is 0.37, which falls within the range of 0.15 to 0.5 and is an indication of good internal consistency. The factor average of 2.3 seems to indicate that the social presence was not strong. The individual statements seem to indicate that respondents were willing to ask classmates for help, perhaps students they considered friends, but that there was not a strong feeling of being part of a group.

4) *Challenges Factor*: Many of the survey statements loaded into a factor that we have referred to as challenges. The results are shown in Table VII, with a Cronbach Alpha of 0.816. The average loading for this factor requires the consideration of individual statements. Although the minority, a significant percentage of students indicated that they did not cope with the workload and what was expected from them. The last three statements also show that many students missed the support, most probably provided by peers, staff and the academic environment. These statements allude to a sense of becoming emotionally overwhelmed in these circumstances.

5) *Assessment Factor*: Four statements loaded into the Assessment factor (see Table VIII) with a Cronbach Alpha of 0.643 and a MITC of 0.31, which is an indication of good internal consistency. Respondents appeared to have a positive perception of the use of continuous assessment with 81.8% of respondents indicating that they preferred continuous assessments and 80.6% indicating that these continuous assessments gave a true reflection of their knowledge. However, somewhat in contradiction to these responses, 48.8% of respondents indicated that sit-down exams were a better way of assessing their learning. It also emerged that many respondents felt that cheating had an impact on the quality of the assessment process. The preliminary qualitative analysis revealed similar findings with a contrast between the types of assessments that students preferred. Although the change from sit-down exams to continuous assessment occurred as a result of this emergency, remote mode, this type of shift in assessment is a fundamental change to assessment and learning and it may be that students and lecturers have not adequately adjusted.

TABLE IV
FACTOR: TEACHING AND LEARNING DESIGN

Statement	Strongly Agree Agree (%)	Factor loading	μ	σ
I was satisfied with the support and guidance I received from lecturers	63.7	0.836	2.33	0.860
I received enough feedback from the lecturer to know if I am making adequate progress	57.9	0.829	2.41	0.863
Clear learning outcomes enabled me to understand what is expected of me	76.5	0.662	2.07	0.726
Most of the material provided was suitable for online learning	81.9	0.625	2.01	0.727
All the study material was made available online	80.4	0.568	1.95	0.766
I was encouraged to challenge or critique different ideas	74.7	0.566	2.13	0.708
I felt comfortable to approach lecturers with questions	65.9	0.538	2.23	0.883
The learning activities supported me to gain a deeper understanding of the content	76.8	0.467	2.06	0.729
Assessments challenged me to reflect critically on the material that was provided	89.0	0.427	1.88	0.612
I feel that I have gained skills that are valuable for my future career	87.3	0.408	1.86	0.701
Factor			2.08	0.527

TABLE V
FACTOR: LEARNING BEHAVIOUR

Statement	Strongly Agree Agree (%)	Factor loading	μ	σ
When I was stuck I searched for different ways to understand the work	94.8	0.688	1.68	0.608
I set goals for myself when I studied	87.6	0.625	1.82	0.650
I have successfully adapted to the online environment	82.9	0.547	1.91	0.753
I could plan my study activities during online learning	84.0	0.506	1.93	0.727
I liked working alone in the online environment	62.6	0.493	2.25	0.928
I am confident that I can apply what I have learned	86.5	0.445	1.87	0.689
Factor			1.9	0.505

V. DISCUSSION

Although respondents generally agreed that their internet quality, the physical environment, and the teaching and learning environment design was adequate; many still found the experience to be overwhelming. This correlates with the Jeffery & Bauer [9] study that describes the experience of many students as feeling lost or hopeless. This finding suggests that understanding the emotional response of students to a remote online learning environment is important. And although for many factors, the average response may be positive, it is important to consider all responses to ensure that "no student is left behind".

Educators should also take into account that the online learning environment should be designed to foster student engagement, not only with the content but also with other students and lecturers, thereby facilitating the development of an online learning community. Many students raised accessibility of lecturers and interaction with other students as a concern during this period. While many students indicated that they formed part of a group and were comfortable to ask classmates for help, a significant number of students did not feel part of the class group, and most students indicated that they needed to struggle on their own. Teaching and learning is by nature a social activity, and educators should consider techniques to establish a strong social presence through two-way communication, group cohesion, and effective expression [20]. The development of a strong community also has the potential to enhance independence, agency, and motivation [13].

Furthermore, self-directed learning skills are also a requirement for online learning [11] and interventions to develop

these skills could mitigate some of the challenges raised by respondents and opportunities should be considered to assist students with this [12].

VI. CONCLUSIONS

The findings reveal some gaps in the presences from the Community of Inquiry model [10] and suggest how these influence the student experience and learning. It is however encouraging to see that many students believe that the gained skills that were valuable for their future careers and that they were challenged to reflect critically on the material which infers the development of higher-order thinking skills [10].

This study has provided useful insights that can be used by educators in similar interventions in the future and the design of online learning environments more broadly. This study also provokes thinking around teaching and learning spaces and how these influence student learning.

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TABLE VI
FACTOR: SOCIAL INTERACTION

Statement	Strongly Agree Agree (%)	Factor loading	μ	σ
I am part of a group who help each other to master module content	60.1	0.848	2.73	0.863
I felt comfortable to ask classmates for help	75.9	0.795	2.04	0.0.817
I did not feel part of the class group in the online environment	44.7	-0.351	2.51	0.913
Factor			2.30	0.505

TABLE VII
FACTOR: COPING

Statement	Strongly Agree Agree (%)	Factor loading	μ	σ
I felt overwhelmed by the amount of work when in the online mode	45.6	0.825	2.48	0.842
I feel that there were too many assessments that I had to do	35.3	0.734	2.61	0.762
The lecturer expected too much of us during this time	34.5	0.682	2.65	0.804
I felt that there was less pressure with the continuous assessment approach	69.3	-0.546	2.11	0.910
I was distracted by other things during online learning	55.0	0.472	2.37	0.844
I had to struggle on my own to figure things out	67.1	0.429	2.11	0.822
I found it difficult to stay motivated during online learning	55.6	0.375	2.33	0.936
Factor			2.49	0.582

TABLE VIII
FACTOR: ASSESSMENT

Statement	Strongly Agree Agree (%)	Factor loading	μ	σ
I feel that sit down exams are a better way of assessing my learning	48.8	0.789	2.49	0.944
Students cheated during online assessments	44.4	0.696	2.56	0.822
I prefer continuous assessments to semester tests and exams	81.8	-0.514	1.83	0.809
Continuous assessments gave a true reflection of my knowledge	80.6	-0.320	1.97	0.761
Factor			2.81	0.585

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