

Validation of Factors Affecting Learning Experience in Emergency Remote Teaching

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Abstract—For more than 2 decades, online or e-learning has been the major approach to distant education. However, a new variant of online learning AKA emergency remote teaching or ERT has emerged and increasingly becoming popular. ERT refers to the temporary transition of educational activities (instruction, assessment, advising) from the traditional to online to avert the crisis. This differs from a typical online or e-learning wherein educational activities are intended to be delivered online and are thus carefully designed, planned and implemented to fulfill this intention. With regards to existing literature, few publications have identified the differences between online learning and ERT, and expressed concerns over the quality of educational activities in ERT. Currently, studies that validate student learning experience in ERT are lacking in literature. ERT is an emerging pedagogical approach that was widely adopted in Spring 2020 due to COVID-19, hence it is imperative to validate its impact in students’ learning experience as well as instructors’ teaching experience. In this research, we focus on the following research question: what factors affect students’ learning experience and instructors’ teaching experience in an emergency remote teaching? To answer this question, we collected data from 240 students and 98 instructors during the implementation of ERT in our institution in Spring and Fall of 2020. Using a combination of ANOVA and Turkey’s Honestly Significantly Difference (HSD), we analyze the data to determine the factors that can be used to predict student learning experience and teaching experience in ERT. Our results of this study will inspire more studies in ERT and inform effective delivery of instructional activities in time of crisis.

Index Terms—Remote Teaching, Covid-19, Pandemic, Learning Engagement, Teaching Effectiveness

I. INTRODUCTION

The outbreak of COVID-19 pandemic in Spring 2020 brought various changes to the academic landscape across the globe. Prominent among these changes is the transition to *Emergency Remote Teaching (ERT)* [1], also known as Emergency Remote Learning (ERL) [2]. As described in literature, ERT refers to the sudden and unplanned shift of instructional activities to distant delivery to avert the crisis [1]–[3]. Even though ERT appears to originate from the distance education theory, it should not be confused with other distant education

models such as e-learning, online learning, remote learning and distance learning. Typically, the idea of distance education is to make instructional activities ubiquitous, so that learners from diverse geographical locations can have access to instruction without being physically present with an instructor in a classroom [4]. Both ERT and the other distance education models leverage the internet as well as other emerging media technologies to provide instruction to students at different geographical locations [4].

However, in a typical distance education model, instructional activities such as teaching and assessment are intended to be delivered from a distant location, usually via the internet or online, and are thus planned and executed. Whereas in the case of ERT, instructional activities originally planned to be delivered in a classroom are suddenly moved to online approach to avert crisis or persist teaching and learning activities amidst crisis [1], [3]. Hodges et al. captures it succinctly and note that well planned distant learning experience are substantially different from courses hurriedly moved to online to avert crisis or disaster [1].

Although the ERT offers various benefits, for instance it provides an avenue for teaching and learning to continue with little to no disruption in the face of natural disaster or pandemic [2]. It has various implications to students’ learning experience as well as faculty teaching experience. Currently, these implications have not been thoroughly studied in literature, if studied at all. The current body of knowledge in ERT focuses on other areas and has not paid due attention to understanding the prevailing pedagogical factors in ERT and how these factors may affect student learning and faculty teaching experiences. The struggles, preparedness, and experiences of parents during an ERT have been investigated in literature, as an example see [5]. Also, there are scholars that have analyzed how the concept of digital divide impacts on learners’ ability to access instructional materials during ERT, see [6]. Other areas of ERT that have been studied in the literature include the comparison and contrasting

of ERT with other distance education models, see [1], [3].

Few scholars have implicitly or otherwise identified some pedagogical factors that could impact teaching and learning experience in an ERT setting. Some examples of these factors include technology (e.g., internet) access [6], emotional stress [2], student motivation and engagement [7] among others. However, available publications have not thoroughly studied, analyzed and validated the factors that have impact on student learning experience as well as faculty teaching experience.

A. Study Significance and Research Question

Insight into the pedagogical factors that affect teaching and learning experience in ERT is important pedagogical improvement for various reasons. First, it could help instructors to make informed decisions on how to structure and delivery their courses during ERT. Given the sudden nature in which classes are transitioned online during ERT, instructors usually do not have sufficient time to design classes. Hence, readily available scholarly information such as the pedagogical factors discussed in this paper would become valuable assets. Secondly, these pedagogical factors could help instructors to develop a set of metrics or variables that can be used to measure the quality of teaching and learning as well as how students are comprehending instructional materials during ERT. For instance, our study finds that peer-to-peer instruction is a measure of student engagement during ERT. The outcome of this study can help instructors to design approaches that will facilitate peer-to-peer interaction during ERT.

Even though the availability of vaccination is curbing the spread of COVID-19, many higher institutions are still practicing ERT and are likely to continue this practice post pandemic. Moreover, the recent crisis in Ukraine has shown that ERT will continue to be relevant even after COVID-19. Therefore, understanding and validating prevailing pedagogical factors that impact student learning and faculty teaching experiences would help to develop effective strategies for continuation of educational activities during crisis. The pedagogical factors in this study could be used as inputs during the development of such strategies.

The aim of this study is to provide insights into the prevailing pedagogical factors in ERT and validate which of these factors have significant impact on students' ability to learn and instructors ability to teach in a typical ERT setting. We believe that these would be beneficial to instructors and institutions currently practicing and those who plan to practice ERT in the future. Hence we focus on the following the research question:

- **RQ** What factors affect students' learning experience and instructors' teaching experience in emergency remote teaching?

We adopt a quantitative approach in answering the research question. Through extensive literature review, we identified prevailing pedagogical factors that may impact student learning and faculty teaching in ERT and distant education in general. Then, we designed a questionnaire in "Survey Monkey" using these factors. After obtaining approval from our Institutional Review Board (IRB), we distributed the questionnaire to collecting data from 240 students and 98 instructors. The data was collected during the implementation of ERT in our institution in Spring and Fall of 2020. We performed statistical analysis on our data set using ANOVA. Although our study is primarily quantitative, we included some open ended questions in the questionnaire to collect students' comments. The rest of the paper is organized as follows, Section II presents the pedagogical factors we identified from literature and reviews existing work relating to ERT. Section III discusses our data collection and analysis approach. The results of our data analysis are presented and discussed in Section IV. Our study limitation, conclusion, and future work are discussed in Section V.

II. LITERATURE REVIEW

The terms "Distance Learning", "E-Learning", and "Online Learning" are becoming popular day by day over the past decades. Moore et al. [4] did a study on understanding different learning environments. They labeled the different learning environments as: distance learning, e-Learning, and online learning and found that they have different expectations and perceptions. Distance learning is a learning environment where the teaching effort is spent for those who are geographically distant instead of in the same classroom with the teacher. With the emerging growth of technology and the availability of tools, the ability to teach from distance has gradually been useful. According to Moor et al., online learning is the most difficult of all three terms mentioned above.

Remote learning has been studied in the literature for decades. One of the early studies on distance learning was performed by Khalifa et al. [8] in 1999. Khalifa investigated the effect of hypertext on individual learning and the effect of group support systems on collaborative learning. They found that more care should be exercised in the design of these remote learning techniques.

Zhang et al. [9] is also one of the early researchers to study e-learning. They studied whether e-learning can replace classroom learning. The current uprising trend of popularity towards e-learning, online universities,

online courses and online training still has not settled the question. Zhang showed a list of advantages and disadvantages of both traditional classroom learning and e-learning. Some of the disadvantages of e-learning are, lack of immediate feedback, increased preparation time for instructions, uncomfortable, and potentially more frustration, anxiety and confusion. This study was conducted eighteen years ago. However some of these disadvantages are still present today. Besides disadvantages, there are advantages of e-learning, such as time and location flexibility, high availability, unlimited access to knowledge, and archival capability. Zhang found that, although there are disadvantages, in a comparative study students in the e-learning setup classroom out-performed the students in the traditional classroom environment by scoring significantly higher in the tests.

Assessment is one of the four factors in our study considered to evaluate students' learning experience in ERT. Remote/online teaching and assessment pedagogy has been improved over this period of time. Many studies have been conducted to evaluate the effectiveness of e-learning already prior Covid-19. In 2014 Wang et al. [10] studied an assessment based e-learning system to investigate the improvement of the learning effectiveness of students. They used two-tier diagnostic assessment and web-based dynamic assessment to develop their e-learning system. They designed the study with two different assessment techniques with and without personalized dynamic assessment. They found that e-Learning models with personalized dynamic assessment are significantly more effective in facilitating student learning achievement and reduction of misconceptions, especially for students with low-level prior knowledge.

Shute and Towel [11] discussed the adaptive e-learning techniques for improving the effectiveness of e-learning using the cutting edge tools and technologies available. Shute proposes that e-learning environments should be flexible enough to accommodate various constructive activities [12]. With the progress of technological development remote teaching and learning environments are receiving increasing popularity and becoming more and more useful in our technology based life-style. However, the challenge of continuous improvement in effective teaching remains high demanding continuous research.

While technology forced us in the direction of an improved and effective e-learning era, the sudden appearance of the Covid-19 global pandemic forced students and educators alike on a high speed treadmill coping with this relatively new mandate of ETR. Emergency Remote Teaching (ETR) becomes a vehicle to continue educating our students while complying with the man-

dates of avoiding physical contact and social distancing.

Hundreds of studies have been published by researchers all around the world during the Covid-19 pandemic to analyze the effect of the Covid-19 measures on the education, emergency remote teaching, e-learning in terms of the quality, teaching and learning effectiveness, and students' engagements and performance [13] [14] [15] [16] [17] [18] [19]. Numerous studies globally as well as for a specific country have investigated the challenges of teaching and learning in a remote environment through technological support.

Sharin did a literature review [15] on e-learning during Covid-19. Since the sudden outbreak began, the education system worldwide has been disrupted dramatically and forced both students and teachers to find an alternative way to continue the educational activities. Since we already had an alternative solution with e-learning, higher education moved forward albeit with many instructors and students having minimal experiences outside of traditional classroom education. However, with the lack of availability of technological support and absence of online classroom habits, almost all educational institutes had to struggle to cope up with the new change. Sharin found that, although there are students and teachers already prepared for e-learning, the complete switch to this mode made the learning sessions less engaging and inefficient.

Although adaptation of distance learning is a brilliant choice, studies show that some students tend to fall behind due to the challenges of personal and technological difficulties. Moreover, taking classes on a small computer screen or mobile device creates significant psychological impacts such as stress and anxiety [20].

Emotional stress is another key factor in our study for evaluating students' and teachers' experience in ERT. Collie. [21] studied emotional exhaustion, and stress of the teachers during the Covid-19. He studied 325 Australian teachers in May 2020 during the first wave of COVID-19. Teachers and students both had to go online immediately with many having little or no or very little experience of studying or teaching online. He focused on two leadership factors among the teachers, "autonomy-supportive" and "autonomy-thwarting" and found that autonomy-thwarting leadership positively associates with the emotional exhaustion while autonomy-supportive type of leadership which is associated indirectly with emotional exhaustion.

More studies on emotional stress have been done by researchers during Covid-19 [22] [23]. Klapproth et al. studied teachers' experiences of stress, the external

and internal barriers for coping up with ERT strategies during Covid-19 among the schools in Germany. They found a large number of teachers experienced medium to high levels of stress while more than half of the teachers spent more than four hours to resolve ERT related challenges with a vast majority of facing technical barriers. Klapproth also identified stress levels in male and female teachers separately where they found that female teachers had experienced significantly more stress compared to the male teachers.

Wester et al. [23] found that students' engagement declines in STEM undergraduate learning in a study on the shift from in-person to online teaching. They observed that there is no significant change in cognitive engagement, and most alarmingly, there is a significant decrease in emotional engagement with a p-value of 0.0075 at the same time, students reporting a drastic decline in positive attitudes toward science courses.

A. Related Works

Studies during the Covid-19 pandemic show us there are many factors involved in the Emergency Remote Teaching (ETR). Although many studies have analyzed some of the factors individually, a general validation of the factors affecting learning experience in ERT is needed. This paper collects such factors and empirically validates their impact on the learning experience in ERT.

Although there are studies before pandemic examining factors that affect learning experience [24] [25], we found very few similar studies have been done since the Covid-19 pandemic has begun. For example, Maheshwari et al. [26] studied the factors affecting students' intention of online-learning during the emergency transfer to remote teaching. The study was conducted among 145 respondents where they divided the affecting factors into extrinsic and intrinsic factors. The extrinsic factors in their study are, gender, age, education level, years of schooling, years of using computers, average time spent on computers etc. Similar to our study, Maheshwari used a one-way ANOVA to test the differences between constructs on the variables collected in the study. They found that extrinsic factors were affected by education level and an average number of hours using a computer.

Another similar study was done by Nguyen and Tran [27] investigating the factors affecting e-learning experience during Covid-19. Nguyen specifically emphasised on students' desire to take upcoming online courses, which eventually proves how much they enjoy online courses. Nguyen used a slightly different set of factors for their study where they considered lecture interaction, self-regulated learning, technical support, skill enhance-

ment, peer interaction, peer support, and finally, desire to take upcoming online courses.

III. METHODOLOGY

A. Data Collection

In order to collect data regarding the experience of students and faculty regarding remote learning, we designed questionnaires using Survey Monkey Software. In particular, the surveys are based on four factors that affect teaching and learning experience in ERT. For the student survey, the specific questions of five factors were designed as follows:

- **Overall Satisfaction (OS):**

- (Student-Q-OS) Overall, how satisfied are you with your current remote teaching experience

- **Student Engagement (SE):**

- (Student-Q-SE-1) I am able to interact and engage with my peers in a seamless way
- (Student-Q-SE-2) I feel I have good interaction with my instructors
- (Student-Q-SE-3) I have timely access to university staff and support services when needed
- (Student-Q-SE-4) I have seamless access to course materials and other university resources

- **Technology Use & Access (TUA):**

- (Student-Q-TUA-1) I am able to seamlessly access university library resource to complete my class assignment
- (Student-Q-TUA-2) I am able to seamlessly join my classes without any interruption
- (Student-Q-TUA-3) My instructors' use of technology in my classes has increased my interest in remote learning
- (Student-Q-TUA-4) Overall, my remote learning and use of technology for my courses meet my expectations.

- **Student Assessment (SA):**

- (Student-Q-SA-1) I receive timely and helpful feedback from my instructors
- (Student-Q-SA-2) I have opportunity to provide feedback to my instructors on my learning experience
- (Student-Q-SA-3) Remote learning does not affect my expected grades in assignments and examinations

- **Emotional Stress (ES):**

- (Student-Q-ES-1) I am able to meet deadlines for submitting my assignments
- (Student-Q-ES-2) I have no pressure combining paid work with study
- (Student-Q-ES-3) Remote learning had no effect on my normal sleep and leisure pattern

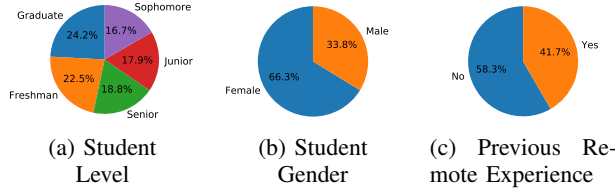


Figure 1: Statistics of Students' Background

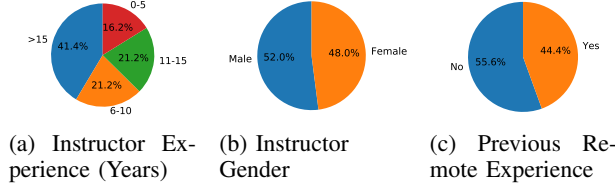


Figure 2: Statistics of Instructors' Background

- (Student-Q-ES-4) Overall, I have no frustration, fear or anxiety related to remote learning

With the perspective of instructors, we designed the following open-ended questions based on the same five factors:

- **Overall Satisfaction (OS):**

- (Instructor-Q-OS) Overall, how satisfied are you with your current remote teaching experience

- **Student Engagement (SE):**

- (Instructor-Q-SE-1) I am able to interact and engage with my students in a seamless way
- (Instructor-Q-SE-2) I have good rapport with my students via the learning management system I use
- (Instructor-Q-SE-3) I have timely access to staff and support services when needed
- (Instructor-Q-SE-4) I have seamless access to course materials and other university resources (Faculty)

- **Technology Use & Access (TUA):**

- (Instructor-Q-TUA-1) I am able to seamlessly access university library resources for lesson planning and student evaluation
- (Instructor-Q-TUA-2) I am able to seamlessly deliver my course materials without any interruption
- (Instructor-Q-TUA-3) Use of technology has enhanced my quality of instructional delivery through remote learning
- (Instructor-Q-TUA-4) Overall, my experience with use of technology for my courses meet my expectations

- **Student Assessment (SA):**

Table I: Cronbach's Alpha

Cronbach's Alpha	Internal Consistency
0.9 ~1.0	Excellent
0.8 ~0.9	Good
0.7 ~0.8	Acceptable
0.6 ~0.7	Questionable
0.5 ~0.6	Poor
0 ~0.5	Unacceptable

Table II: Cronbach's Alpha of Student Survey

Factor	Cronbach's Alpha
Student Engagement	0.829
Technology Use and Access	0.831
Student Assessment	0.804
Emotional Stress	0.842

- (Instructor-Q-SA-1) I am able to provide timely and helpful feedback to my students
- (Instructor-Q-SA-2) I have opportunity to gather feedback on student learning experience
- (Instructor-Q-SA-3) Remote learning does not have any effect on the way I grade student assignments and examinations

- **Emotional Stress (ES):**

- (Instructor-Q-ES-1) Preparation for online teaching requires more time than traditional in-class teaching
- (Instructor-Q-ES-2) I have no pressure delivering my courses remotely
- (Instructor-Q-ES-3) Remote teaching had no effect on my work schedule and other academic deliverables
- (Instructor-Q-ES-4) Overall, I have experienced no frustration, fear or anxiety related to remote teaching

Data collected over Spring of 2020 (March to May) to coincide with the first coronavirus wave when most institutions transitioned to remote learning. In total, 338 participants from Gannon University are involved, which includes 240 students and 98 faculty. Majority of our student respondents are from STEM disciplines including majors such as Mechanical Engineering, Information Systems and Computer Science. The specific background information of student and faculty respondents are shown in Figure 1 and Figure 2, respectively.

The detailed analysis about how those four factors impact learning experience of ERT is presented in the following subsections, where we use Python Pandas to plot descriptive charts and perform ANOVA analysis.

B. Validation of Instrument Cronbach's Alpha

We use Chronbach's Alpha to measure the internal consistency of our survey results. As shown in Table I Cronbach's Alpha ranges between 0 and 1, with higher values indicating that the survey is more reliable.

Table III: Cronbach's Alpha of Instructor Survey

Factor	Cronbach's Alpha
Student Engagement	0.713
Technology Use and Access	0.723
Student Assessment	0.702
Emotional Stress	0.741

The survey for students includes 16 questions in total. The Cronbach's Alpha turns out to be 0.850. The 99% confidence interval for Cronbach's Alpha is also given from 0.804 to 0.886. The result indicates that the internal consistency of this survey is "Good". The detailed Cronbach's Alpha of each factor is shown in Table II. The survey for faculty also includes 16 questions in total. The Cronbach's Alpha turns out to be 0.747, which is not as good as the student survey because the number of faculty responses is less than the student responses. The 99% confidence interval for Cronbach's Alpha is also given from 0.619 to 0.838. The result indicates that the internal consistency of this survey is "Acceptable". The detailed Cronbach's Alpha of each factor is shown in Table III.

C. ANOVA Analysis Based On Ordinary Least Squares (OLS) Model

We use Analysis of variance (ANOVA) to check if the means of groups are significantly different from each other. There are five factors in our designed survey: "Overall Satisfaction (OS)", "Student Engagement (SE)", "Technology Use and Access (TUA)", "Student Assessment (SA)", and "Emotional Stress (ES)", which are groups for ANOVA analysis. ANOVA checks the impact of those groups on student learning experience by comparing the means of different ratings. We also perform a further analysis to determine the significance of each of these factors to both student learning experience and faculty teaching experience. This analysis was performed using the Tukey's Honestly Significantly Difference (HSD) Test.

To perform the ANOVA Analysis, we first convert the survey data collected with Likert Scale to numerical values. More specifically, we assign numbers to each response as follows: "Strongly Agree" corresponds to the 5. "Agree" corresponds to the 4. "Neither" corresponds to the 3. "Disagree" corresponds to the 2. "Strongly Disagree" corresponds to the 1.

IV. RESULTS AND DISCUSSION

The results of our ANOVA for both students and faculty factors are shown in Table IV and Table V respectively. Our aim in performing ANOVA is to check for significance difference in the four factors used in our study, i.e., Student Experience (SE), Technology Use and Access (TUA), Student Assessment (SA), and Emotional

Stress. We also included the Overall Satisfaction (OS). As seen in both tables, the p-value obtained from our ANOVA is significant ($p < 0.05$). This shows that there are significant differences among these four factors. But ANOVA does not indicate the individual significance or how influential each factor is to student learning experience and faculty teaching experience.

Table IV: ANOVA Analysis for Student Survey

	sum_sq	df	F	p-value
Factors	113.143578	4.0	12.998313	2.305446e-10
Residual	2591.759432	1191.0	NaN	NaN

Table V: ANOVA Analysis for Instructor Survey

	sum_sq	df	F	p-value
Factors	36.068687	4.0	5.493745	0.000247
Residual	804.262626	490.0	NaN	NaN

To gain insight into the individual impact of each factor to the student learning experience and faculty teaching experience in ERT, we compute the Honestly Significant Difference (HSD) values. Using the HSD approach we compared the Overall Student Satisfaction (OS) of ERT with each of the other four factors i.e., Student Engagement (SE), Technology Use and Access (TUA), Student Assessment (SA) and Emotional Stress (ES). The result of our HSD values for student factors are shown in Table VI while the HSD values for faculty factors are shown in Table VII. As presented in Table VI the HSD p-value for Student Engagement (SE) and Technology Use and Access (TUA) are both 0.9. While that of Student Assessment (SA) and Emotional Stress (ES) are 0.68 and 0.001 respectively. Hence, the two most significant factors that can impact student learning experience in ERT are student engagement and technology use and access. On the other hand, emotional stress (ES) appears not to have a significant impact on student learning experience in an ERT.

Table VII compares the overall satisfaction of faculty or instructors' teaching experience in ERT with the other four factors i.e., SE, TUA, SA and ES. As shown in this table, the HSD p-values for TUA and ES are 0.35 and 0.155 respectively. These are lower than the HSD p-values for SE and SA which are 0.68 and 0.65 respectively. This shows that Technology use and Access (TUA) and Emotional Stress (ES) have a lesser significant impact on faculty teaching experience in ERT than Student Engagement (SE) and Student Assessment (SA). This is not surprising, especially for TUA because most faculty members already engage in professional and faculty development that may include training on the use of teaching and learning technology.

However, it is critical to note that the HSD p-value for Emotional Stress (ES) from faculty perspectives is 0.155 is greater and more significant than that of student which is 0.001. This may be an indication that faculty members are likely to experience more emotional stress during ERT than students.

The pie charts for “NO” “Previous Remote Experience” was very high at 58 percent for students and 55 percent for faculty. It is safe to say that this percentage of “no experience” shall remain much lower for the foreseeable future.

A. Answers to the Research Question

One important goal of this research is to understand the pedagogical factors that can be used to predict student learning experience and faculty teaching experience in ERT. This goal informed our research question presented in Section I-A. We can use the result of our data analysis to deduce answers to these questions. As discussed in the preceding sections, the following factors have significant HSD p-values from students’ perspectives: Student Engagement (SE), Technology Use and Access (TUA), and Student Assessment (SA). Hence these three factors can be used to predict student learning experience in ERT. Similarly, Student Engagement (SE), and Student Assessment (SA) have the most significant values from faculty perspectives and therefore can be used to predict faculty teaching experience in ERT.

This study suggests higher education institutions and faculty need to focus on Student Engagement and Student Assessment to improve an ERT experience from both the student and faculty perspectives. Additionally, students’ also want higher education to focus on Technology Use and Access. It will be helpful for an institution to list the hardware and software needs expected in each course as well as include the possibility of ERT in business contingency plans. Our institution provides computer centers and loaner laptops on a limited basis; however, Covid 19 mandates included social distancing and possibly quarantining which makes computer labs useless. Even though McDonalds has free wifi, not all students/teachers had access to a McDonald’s or their own WiFi. The internet and Zoom were floated with the massive surge in usage causing access issues.

V. CONCLUSION, STUDY LIMITATION, AND FUTURE WORK

Emergency remote teaching (ERT), that is the sudden and unplanned shift of academic activities online to aver crisis, became a popular and alternative pedagogical approach in Spring 2020, during COVID-19. Although much progress has been made in curbing the effect of COVID-19, other factors e.g., the crisis in Ukraine, and

natural disasters are likely to make ERT a mainstream pedagogical approach. Therefore, it is important to gain insight into the prevailing pedagogical factors that impact student learning experience and faculty teaching experience in ERT. Insight into these pedagogical factors could provide guidelines for making informed decisions by instructors and institutions. Moreover, these factors may be used as metrics to assess the quality of instructional activities during ERT.

In this research, we identified four key pedagogical, as reported in literature, that are likely to impact student learning experience and faculty teaching experience in ERT. These factors include Student Engagement (SE), Technology Use and Access (TUA), Student Assessment (SA) and Emotional Stress (ES). After data collection, we tested the statistical significance of these factors to determine if they can be used to predict student learning and faculty teaching experiences in ERT. We find that SE, TUA and SA have significant impact and are good predictor of student learning experience in ERT. While SE and SA are most significant factors that can be used to predict faculty teaching experience in an ERT. Although, students and faculty experienced emotional stress during ERT, statistical analysis shows that emotional stress is less significant from both student and faculty experience.

This study has some implications that may be useful to instructors and institutions already implementing or who plan to implement ERT in the future. During instructional design for ERT, instructors should look for online activities that foster student engagement, peer-to-peer interactions, and student-to-faculty interactions. Secondly, since technology use and access is another significant factor that impact student learning experience, institution should design workshops, training and activities that to help students to learn various learning technologies used during ERT. These workshops and activities may be proactively integrated and used in course delivery even in a traditional classroom or other distant learning environment. For instance, institutions can design workshops or non-credit bearing courses to train students on how to use technologies such as Zoom that are useful during ERT. Students should also be taught different ways to obtain reliable internet access including making your smart phone a hot spot.

A. Study Limitation and Future Work

Even though instructors, students and institutions may use the results and findings of our study to prepare for ERT. It is important to point out some factors that may limit the ability of these results to be generalized. One of such factors is the response rate, less than 5% of student population responded to our survey. Hence, the data and

Table VI: Tukey's HSD Test for Student Survey

	group1	group2	Diff	Lower	Upper	q-value	p-value
0	Student-OS	Student-SE	0.118741	-0.249539	0.487021	1.245696	0.900000
1	Student-OS	Student-TUA	0.036070	-0.332210	0.404351	0.378409	0.900000
2	Student-OS	Student-SA	0.169962	-0.198318	0.538242	1.783041	0.689888
3	Student-OS	Student-ES	0.755736	0.387456	1.124016	7.928304	0.001000
4	Student-SE	Student-TUA	0.154812	-0.213853	0.523476	1.622413	0.754290
5	Student-SE	Student-SA	0.288703	-0.079961	0.657367	3.025580	0.204089
6	Student-SE	Student-ES	0.874477	0.505813	1.243141	9.164439	0.001000
7	Student-TUA	Student-SA	0.133891	-0.234773	0.502556	1.403168	0.842194
8	Student-TUA	Student-ES	0.719665	0.351001	1.088330	7.542026	0.001000
9	Student-SA	Student-ES	0.585774	0.217110	0.954438	6.138858	0.001000

Table VII: Tukey's HSD Test for Instructor Survey

	group1	group2	Diff	Lower	Upper	q-value	p-value
0	Instructor-OS	Instructor-SE	0.232323	-0.266250	0.730896	1.804302	0.681489
1	Instructor-OS	Instructor-TUA	0.333333	-0.165240	0.831906	2.588782	0.357667
2	Instructor-OS	Instructor-SA	0.242424	-0.256149	0.740997	1.882750	0.650076
3	Instructor-OS	Instructor-ES	0.414141	-0.084432	0.912715	3.216365	0.155041
4	Instructor-SE	Instructor-TUA	0.101010	-0.397563	0.599583	0.784479	0.900000
5	Instructor-SE	Instructor-SA	0.010101	-0.488472	0.508674	0.078448	0.900000
6	Instructor-SE	Instructor-ES	0.646465	0.147891	1.145038	5.020668	0.003852
7	Instructor-TUA	Instructor-SA	0.090909	-0.407664	0.589482	0.706031	0.900000
8	Instructor-TUA	Instructor-ES	0.747475	0.248902	1.246048	5.805147	0.001000
9	Instructor-SA	Instructor-ES	0.656566	0.157993	1.155139	5.099116	0.003153

responses may not be representative of general student population. More so, since the data used for our study was collected from a single institution, certain institutional or homogeneous factors that impact students and instructors' perception may be at play here; these are not accounted for in our study. Moreover, data was collected in the weeks leading to exams and a few weeks into the lockdown being experimental days for many students and instructors on how ERT works. Finally, emergency move to remote education as a result of COVID-19 is unprecedented and relatively new providing no basis for comparison. Our future study will focus on conducting a robust study, expanding our sample size and collection data from multiple institutions. We already have started collecting the data for 2021 and working on our future plan. This will help to reduce or even eliminate some of the limitations we discussed above. We will also conduct further statistical analysis e.g., factor analysis, to identify how each of these four factors impact student learning and faculty teaching experiences. Furthermore, we are interested in finding out the preferred student engagement technique in a typical ERT. Various instructional techniques such as flipped classroom [28], game-based learning [29], project based-learning [30], and persuasive technologies [31] have been discussed in literature. We would want to investigate how and if these techniques can be used during ERT.

REFERENCES

- [1] C. B. Hodges, S. Moore, B. B. Lockee, T. Trust, and M. A. Bond, "The difference between emergency remote teaching and online learning," 2020.
- [2] M. D. Rahiem, "The emergency remote learning experience of university students in indonesia amidst the covid-19 crisis," *International Journal of Learning, Teaching and Educational Research*, vol. 19, no. 6, pp. 1–26, 2020.
- [3] S. Shisley, "Emergency remote learning compared to online learning," *Learning Solutions*, 2020.
- [4] J. L. Moore, C. Dickson-Deane, and K. Galyen, "e-learning, online learning, and distance learning environments: Are they the same?" *The Internet and higher education*, vol. 14, no. 2, pp. 129–135, 2011.
- [5] A. Garbe, U. Ogurlu, N. Logan, and P. Cook, "Covid-19 and remote learning: Experiences of parents with children during the pandemic," *American Journal of Qualitative Research*, vol. 4, no. 3, pp. 45–65, 2020.
- [6] O. B. Azubuike, O. Adegboye, and H. Quadri, "Who gets to learn in a pandemic? exploring the digital divide in remote learning during the covid-19 pandemic in nigeria," *International Journal of Educational Research Open*, vol. 2, p. 100022, 2021.
- [7] X. Bai, A. Ola, S. Reese, E. Eyob, and S. Bazemore, "A study of the effectiveness of remote instruction from students' perspectives," *Issues in Information Systems*, vol. 21, no. 4, 2020.
- [8] M. Khalifa and R. C.-W. Kwok, "Remote learning technologies: effectiveness of hypertext and gss," *Decision Support Systems*, vol. 26, no. 3, pp. 195–207, 1999.
- [9] D. Zhang, J. L. Zhao, L. Zhou, and J. F. Nunamaker Jr, "Can e-learning replace classroom learning?" *Communications of the ACM*, vol. 47, no. 5, pp. 75–79, 2004.
- [10] T.-H. Wang, "Developing an assessment-centered e-learning system for improving student learning effectiveness," *Computers & Education*, vol. 73, pp. 189–203, 2014.

- [11] V. Shute and B. Towle, "Adaptive e-learning," in *Educational psychologist*. Routledge, 2018, pp. 105–114.
- [12] V. J. Shute and L. A. Gawlick, "Practice effects on skill acquisition, learning outcome, retention, and sensitivity to relearning," *Human Factors*, vol. 37, no. 4, pp. 781–803, 1995.
- [13] K. Kulikowski, S. Przytuła, and Ł. Sułkowski, "The motivation of academics in remote teaching during the covid-19 pandemic in polish universities—opening the debate on a new equilibrium in e-learning," *Sustainability*, vol. 13, no. 5, p. 2752, 2021.
- [14] R. ElSaheli-Elhage, "Access to students and parents and levels of preparedness of educators during the covid-19 emergency transition to e-learning," *International Journal on Studies in Education (IJonSE)*, vol. 3, no. 2, pp. 61–69, 2021.
- [15] A. N. Sharin, "E-learning during covid-19 a review of literature," *Jurnal Pengajian Media Malaysia*, vol. 23, no. 1, 2021.
- [16] D. A. Fitzgerald, K. M. Scott, and M. S. Ryan, "Blended and e-learning in pediatric education: harnessing lessons learned from the covid-19 pandemic," *European journal of pediatrics*, pp. 1–6, 2021.
- [17] E. Aboagye, J. A. Yawson, and K. N. Appiah, "Covid-19 and e-learning: The challenges of students in tertiary institutions," *Social Education Research*, pp. 1–8, 2021.
- [18] C. Peñarrubia-Lozano, M. Segura-Berges, M. Lizalde-Gil, and J. C. Bustamante, "A qualitative analysis of implementing e-learning during the covid-19 lockdown," *Sustainability*, vol. 13, no. 6, p. 3317, 2021.
- [19] R. A. Abumalloh, S. Asadi, M. Nilashi, B. Minaei-Bidgoli, F. K. Nayer, S. Samad, S. Mohd, and O. Ibrahim, "The impact of coronavirus pandemic (covid-19) on education: The role of virtual and remote laboratories in education," *Technology in Society*, vol. 67, p. 101728, 2021.
- [20] N. Liu, F. Zhang, C. Wei, Y. Jia, Z. Shang, L. Sun, L. Wu, Z. Sun, Y. Zhou, Y. Wang, and W. Liu, "Prevalence and predictors of ptss during covid-19 outbreak in china hardest-hit areas: Gender differences matter," *Psychiatry Research*, vol. 287, p. 112921, 2020.
- [21] R. J. Collie, "Covid-19 and teachers' somatic burden, stress, and emotional exhaustion: examining the role of principal leadership and workplace buoyancy," *Aera Open*, vol. 7, p. 2332858420986187, 2021.
- [22] F. Klapproth, L. Federkeil, F. Heinschke, and T. Jungmann, "Teachers' experiences of stress and their coping strategies during covid-19 induced distance teaching," *Journal of Pedagogical Research*, vol. 4, no. 4, pp. 444–452, 2020.
- [23] E. R. Wester, L. L. Walsh, S. Arango-Caro, and K. L. Callis-Duehl, "Student engagement declines in stem undergraduates during covid-19–driven remote learning," *Journal of microbiology & biology education*, vol. 22, no. 1, pp. ev22i1–2385, 2021.
- [24] M. N. Giannakos, "Enjoy and learn with educational games: Examining factors affecting learning performance," *Computers & Education*, vol. 68, pp. 429–439, 2013.
- [25] W. G. M. Ali, "Factors affecting nursing student's satisfaction with e-learning experience in king khalid university, saudi arabia," *dimension*, vol. 5, pp. 13–18, 2012.
- [26] G. Maheshwari, "Factors affecting students' intentions to undertake online learning: an empirical study in vietnam," *Education and Information Technologies*, vol. 26, no. 6, pp. 6629–6649, 2021.
- [27] N. T. Nguyen and H. T. T. Tran, "Factors affecting students' desire to take upcoming online courses after e-learning experience during covid-19," *iJIM*, vol. 16, no. 01, p. 23, 2022.
- [28] J. C. Nwokeji and T. S. Holmes, "The impact of learning styles on student performance in flipped pedagogy," in *2017 IEEE Frontiers in Education Conference (FIE)*. IEEE, 2017, pp. 1–7.
- [29] A. Fuster-Guilló, M. L. Pertegal-Felices, A. Jimeno-Morenilla, J. Azorín-López, M. L. Rico-Soliveres, and F. Restrepo-Calle, "Evaluating impact on motivation and academic performance of a game-based learning experience using kahoot," *Frontiers in Psychology*, vol. 10, p. 2843, 2019.
- [30] J. C. Nwokeji and P. S. T. Frezza, "Cross-course project-based learning in requirements engineering: An eight-year retrospective," in *2017 IEEE Frontiers in Education Conference (FIE)*. IEEE, 2017, pp. 1–9.
- [31] A. M. Abdullahi, R. Orji, and J. C. Nwokeji, "Personalizing persuasive educational technologies to learners' cognitive ability," in *2018 IEEE Frontiers in Education Conference (FIE)*. IEEE, 2018, pp. 1–9.