# ADAPTABILITY AND SELF-EVALUATION IN ONLINE CONTEXT DURING COVID-19: AN INVESTIGATION OF POSTGRADUATE ENGINEERING STUDENTS

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**Abstract:** Engineering courses require teaching methods that combine theory with practice. Engineering institutions have implemented measures to ensure continuity in education during the COVID-19 pandemic. However, educators still face significant challenges, such as a lack of access to large laboratory equipment and challenges in presenting and communicating with students. The acceptability and effectiveness of the new online engineering education delivery methods are still critical for students, especially those arriving during the pandemic. To examine the direct impact of the pandemic on postgraduate taught engineering (PGTE) students, this study focused on one-year PGTE students' self-evaluation of learning outcomes.
This cross-sectional survey adopts interviews and web-based questionnaire research methods to collect data and conduct statistical analysis. Over 300 engineering students were surveyed to collect the data analysed. The study aims to assess online presence, learning engagement, and self-efficacy of one-year PGTE students and explore the correlations among them, making recommendations in regular online teaching improvements to high education providers for post-COVID-19 period, as well as better preparation for temporary disruptions in the future.

*Keywords; COVID-19 pandemic, postgraduate taught engineering, adaptability, self-evaluation*

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## 1. INTRODUCTION

### *1.1 The purpose of the Research*

Traditionally, engineering education was content-based, design-oriented, and focused on developing critical thinking or problem-solving skills (Bourne et al., 2005). Recently, problem-based learning for team building and collaboration has been added (Edström et al., 2014). Since 2020, to curb the spread of the Covid-19 pandemic, most of the world's educational institutions have transitioned to an online delivery model. Engineering education has specific requirements in the distance mode, such as effectively providing hands-on science and engineering experience (Asgari et al., 2021). The cognition and emotion of students have fluctuated and changed due to online education being the learning medium. After the pandemic, traditional campus-based education providers may embrace blended learning strategies, combining in-person instruction with online learning (Naidu et al., 2022). Researchers suggest that educators should concentrate on students' thoughts and beliefs as a foundation for reengineering education systems for the post-COVID-19 era (Neuwirth et al., 2021).

It is more challenging for postgraduate taught engineering (PGTE) students, with programmes of one year, to swiftly adapt to a new online pattern. They are forced to self-regulate in a short period, manage complex knowledge, and resist the stresses of job hunting at the same time. Indicators such as online presence, learning engagement and self-efficacy assessments have been identified as key factors influencing learning success and are important measures of quality learning and teaching in higher education (Roffe, 2002; Hutchison et al., 2006). Current research has limited knowledge of the impact of online instructions on the online presence and engagement of PTGE students affected by COVID-19. Therefore, it is vital to examine these aspects and their connections from an integrated perspective.

The study aims to identify the factors and their correlations contributing to the effectiveness of online delivery. In the survey, adaptability was measured as two indicators: learning engagement and online presence, which are specific for online classes during the pandemic. Specifically, this study will answer the following three questions:

RQ1: How satisfied are PGTE students enrolled during COVID-19 of the online programme regarding the two (learning engagement, online presence) perspectives of adaptability?

RQ2: What competencies of PGTE students were increased from the online course?

RQ3: What is the correlation between online presence and learning engagement with the online self-efficacy of PGTE students?

## 2. LITERATURE REVIEW

The visualisation, high-speed processing, and high-levelled control of online technologies offer a variety of benefits to higher education, including accessibility, interactivity, and improved comfort (Haper et al., 2004). According to research, many online models have emerged for engineering education that enhance immersion and engagement, such as flipped classrooms in adaptive learning courses (Kakosimos, 2015), project-based learning (Edström et al., 2014), online lectures that enhance independent learning; educational platforms and simulations that transfer experiments to the web (Goman et al., 2022). By arriving in the post-epidemic era, students will continue to be educated in a traditional face-to-face model on a global scale (Lockee, 2021). The conventional campus educational experience should draw on the ability of online learning to create more flexible and technology-enhanced learning (Volery et al., 2002).

Previous research has identified adaptability significantly predicted the academic performance of secondary and university students through learning engagement (Martin et al., 2013). Still, past works focused on traditional offline classroom models (Fredricks et al., 2004; Collie et al., 2016). The research on the similar impact of online settings in specific pandemic contexts research remains limited.

### 2.1 Conceptual underpinnings

Adaptability refers to the ability to self-regulate cognitively, behaviourally, and emotionally in response to novelty, change, or unpredictable conditions, a tripartite model of adaptation proposed by Martin (Martin et al., 2013). Student adaptability is positioned as a specific type of self-regulation, and it is a predictor of student self-evaluation. PTGE students are more likely to need strong adaptability to adapt quickly to new situations in a shorter period.

Online Presence: Russo proposes that online learning is achieved through the interaction of teaching, social, cognitive presence (Russo et al., 2005). Teaching presence can be interpreted as teacher visibility, influencing student engagement and participation (Caskurlu et al., 2020). Social presence refers to social activities through the online environment; cognitive presence refers to the extent to which participants can gain engagement through sustained communication (Garrison, 2000).

Learning engagement is critical to learner success in online learning environments. The Programme for International Student Assessment (PISA) uses learning engagement as one of the indicators of the quality of schooling (Ainley et al., 2011), and learning engagement is a multifaceted construct that includes three dimensions: behavioural, emotional, and cognitive. (Fredricks et al., 2004). Behavioural engagement refers to students' engagement in learning activities measured by effort, persistence, and attention; emotional engagement refers to students' display of emotions such as enthusiasm and interest, boredom and anxiety; and cognitive engagement refers to the use of active self-regulation and learning strategies. (Fredricks et al., 2004; Nagel et al.,2010).

Self-efficacy is conceptualised as a personal belief regarding the abilities and skills necessary to attain desired results (Bandura, 1986). Self-efficacy is a critical belief in self-regulatory control (Van et al., 2011), and researchers have discovered that students with strong academic self-efficacy tend to be more interested in their studying (Wang et al., 2013).

## 3. RESEARCH METHODS

### *3.1 Study methods*

To address the research questions, this study used a survey questionnaire tool to collect respondents' data as Vehovar's online survey research method (Vehovar et al., 2008). We used interviews as the first step to ensure the questionnaire design was applied to the target respondents (Desimone et al., 2004). The in-depth, semi-structured interviews were conducted with 10 PGTE students in one month, each lasting approximately 30 minutes, aiming to refine the questionnaire design. The interview questions addressed online specific behaviours and experiences, including changes in self-regulation, learning engagement, time management, and physical and mental health for PGTE students, a better match to PGTE students.

With the information collected from the interviews, the questionnaire was slightly modified and divided into the following categories: demographic information, teaching presence measurement framework (Zhang et al., 2022), University Student Engagement Inventory (USEI) (Maroco et al., 2016), and Online Learning Self-Efficacy Scale (OLSES) (Zimmerman et al.,2016). A pilot study with 10 PGTE students was conducted. The validity and reliability of the pilot questionnaire were tested, as the Cronbach's alpha (CA>0.7). To ensure the inaccurate effects of time on memory and perception, we conducted survey with students who had taken online classes within a year of the questionnaire's release. The students assessed the questionnaire items from 1 (strongly disagree) to 5 (strongly agree) on a five-point Likert scale. For each component, 5-point Likert scale item responses were averaged to provide a composite response, with higher scores indicating greater satisfaction.

### *3.2 Statistical analysis*

SPSS 22.0 was used to analyse descriptive statistics and test the reliability and validity. Reliability for the factors was evaluated by the factors' internal consistency evaluated by Cronbach's Alpha. Table 1 shows the results of reliability and validity tests. Cronbach's Alpha (CA>0.7) was

indicative of acceptable internal consistency for exploratory research. Average Variance Extraction (AVE>0.5) and combined reliability (CR>0.7) for high convergent validity. The Kaiser-Meyer-Olkin (KMO>0.6) means that the data are valid and pass the validity test (Dziuban et al.,1974). The data satisfied the skewness and kurtosis conditions for each construct. (All absolute Sk and Ku values < 2) (Green et al., 2005).

| Item | No. of items | CA | KMO | AVE | CR |
|---|---|---|---|---|---|
| Online Presence | 15 | 0.921 | 0.86 | 0.78 | 0.92 |
| Learning Engagement | 12 | 0.91 | 0.82 | 0.82 | 0.94 |
| OLSES | 12 | 0.908 | 0.88 | 0.88 | 0.92 |

*Abbreviations: CA, Cronbach's Alpha; KMO, Kaiser-Meyer-Olkin; AVE, Average Variance Extraction; CR, combined reliability*

**Table 1 The reliability and validity for substantive factors.**

## 4. RESULTS

### *4.1Participants*

The survey invitation was sent to a sample of 500 PTGE students who will earn their Master of Engineering in 2022, and 310 responded to it. However, 37 people who finished the questionnaire in less than 2 minutes were excluded from the data analysis. In addition, six outliers were detected and removed. Finally, the scripts of 264 learners were analysed using.

### *4.2 Descriptive statistics*

The descriptive statistics of the substantive factors are presented in Table 2. Combining the scores of 4 and 5 into satisfaction, PGTE showed that the overall condition of online teaching behaviour was good: teaching presence had the highest satisfaction (68%), cognitive participation was higher (57%), and social presence was about half of the satisfaction (55%), among which students had a low score of interest in online courses, which was their intrinsic perception of the courses, directly affecting their input and concentration. In the participation survey, the behaviour participation of students with an intermediate level of online learning participation was the highest (82%), but emotional participation (48%) and cognitive participation (52%) were not high enough. The overall self-efficacy satisfaction of PGTE students was average (62%).

| Online Presence | Question | M | SD | SR |
|---|---|---|---|---|
| TP | 1. Important class objectives and subjects are clearly delivered. | 3.95 | 0.96 | 74% |
| | 2. Learning timetables/schedules are well delivered. | 4.03 | 0.957 | 80% |
| | 3. The teacher help me discussing effectively in class. | 3.58 | 1.034 | 56% |
| | 4. The teacher could provide timely classroom feedback about me. | 3.6 | 1.055 | 58% |
| | 5. Teacher encourages me to explore new ideas in the lesson. | 3.83 | 0.937 | 70% |
| SP | 1. I felt comfortable participating in the course discussions. | 3.48 | 0.961 | 49% |
| | 2. I feel comfortable interacting with other course participants. | 3.44 | 0.943 | 46% |
| | 3. I feel comfortable communicating with the online medium. | 3.83 | 1.005 | 68% |
| | 4. I feel comfortable in maintaining a sense of trust when I disagree with other course participants. | 3.64 | 0.917 | 59% |
| | 5.Online communication is a great medium for communicating with others. | 3.4 | 1.076 | 46% |
| CP | 1. The online discussions have been valuable in helping me to discover different perspectives and viewpoints. | 3.56 | 0.902 | 56% |
| | 2. Incorporating new information helps me answer questions in course. | 3.73 | 0.864 | 68% |
| | 3. The learning activities in the course help me build an analytical solution. | 3.67 | 0.905 | 61% |
| | 4. Questions asked by the teacher increased my interest in the course. | 3.49 | 0.977 | 64% |
| | 5. I am motivated to explore questions related to the course content. | 3.5 | 0.977 | 55% |
| Learning Engagement | Question | M | SD | SR |
| BE | 1. I followed the rules and arrangements of the online course. | 4.05 | 0.907 | 78% |

| | | | | |
|---|---|---|---|---|
| | 2. I participated in online discussions about the course content. | 4.09 | 0.86 | 77% |
| | 3. I completed course-related tests and assessments. | 4.28 | 0.794 | 87% |
| EE | 1. I like the online courses. | 3.53 | 1.007 | 73% |
| | 2. I am satisfied with the effort I put into my online courses. | 3.46 | 0.999 | 72% |
| | 3. I think the online course is interesting. | 3.34 | 1.054 | 57% |
| | 4. I am interested in the tasks in the online course. | 3.3 | 1.075 | 69% |
| | 5. I can stay happy during the online course. | 3.5 | 1.008 | 58% |
| CE | 1. When reading the course material, I ask myself to ensure I understand the content. | 3.58 | 0.838 | 42% |
| | 2.I can maintain self-discipline in my online learning process.<br>3. I am proactive in my online learning. | 3.24 | 0.966 | 54% |
| | 4.I can think about relevant issues during my online learning. | 3.2 | 1.075 | 56% |
| OSLES Questions | | M | SD | SR |
| | 1. You will be able to check your completion status and keep track of your learning progress during online learning. | 3.95 | 0.96 | 69% |
| | 2. I think I can keep up to date with the course content as it is being taught. | 4.03 | 0.957 | 75% |
| | 3. I am confident that I can complete tasks and questions assigned to me for e-learning. | 3.58 | 1.034 | 63% |
| | 4. I am confident that I can solve learning problems that I encounter during online learning. | 3.6 | 1.055 | 73% |
| | 5. I believe that I can achieve the same or better results in online courses than in offline teaching. | 3.83 | 0.937 | 58% |
| | 6. I can face difficulties in e-learning calmly because I trust my ability to deal with such problems. | 3.48 | 0.961 | 70% |
| | 7. Discussions with classmates or teachers through the learning platform are easy for me and I can adapt easily. | 3.44 | 0.943 | 60% |
| | 8. I can always submit completed assignments to the online platform accurately | 3.83 | 1.005 | 75% |
| | 9. Online learning does not leave me without a sense of atmosphere. | 3.64 | 0.917 | 38% |
| | 10. I can quickly embrace online group learning. | 3.4 | 1.076 | 61% |
| | 11. I can manage my time effectively to keep on top of my learning tasks. | 3.56 | 0.902 | 56% |
| | 12. I can quickly adjust to negative feelings about learning and keep studying. | 3.73 | 0.864 | 51% |

*Abbreviations: M, Average, SD, standard deviation, SR, Satisfaction rate*

**Table 2 The descriptive statistics of the substantive factors.**

Through the survey about PGTE students' competency enhancement in online courses, the most prominent was the use of information technology (e.g. document retrieval and PPT production), scoring the highest (4.14), followed by self-learning skills (4.09), professional knowledge and skills (4.01), and the lowest scores for English speaking skills (3.02) and good study habits (3.45), indicating that online learning needs to focus on ways to manage and enhance competencies that complement these aspects.

### *4.3 Correlation analysis*

| demission | | Online Presence | | | | Learning Engagement | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | TP | SP | CP | TOTAL | BE | EE | CE | TOTAL | OLSES |
| Online Presence | TP | 1 | | | | | | | | |
| | SP | .565** | 1 | | | | | | | |
| | CP | .405** | .588** | 1 | | | | | | |
| | TOTAL | .806** | .870** | .797** | 1 | | | | | |
| Learning Engagement | BE | .546** | .570** | .386** | .610** | 1 | | | | |
| | EE | .360** | .491** | .671** | .611** | .371** | 1 | | | |
| | CE | .433** | .371** | .548** | .544** | .412** | .732** | 1 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | TOTAL | .534** | .576** | .661** | .714** | .695** | .877** | .881** | 1 |
| OSLES | | .450** | .583** | .576** | .649** | .581** | .640** | .659** | .763** | 1 |

*Overall goodness of fit for the correlational model: $\chi 2/df = 2.1$; CFI = .96; TLI = .93; RMSEA = .076; n = 264). All correlations are statistically significant for ** P <0.01 *P <0.05 Abbreviations: TP, Teaching Presence; SP, Social Presence; CP, Cognitive Presence; BE, Behavioural Engagement; EE, Emotional Engagement; CE, Cognitive Engagement; Average, SD, standard deviation, SR, Satisfaction rate*

**Table 3 Estimated latent correlations among substantive factors.**

Pearson's correlation analysis was conducted, which showed that Online Presence was significantly and positively correlated with the overall Learning Engagement score ($r=0.714$, $p<0.05$), with a strong correlation strength. Online Presence was significantly positively correlated with Online Learning Self-Efficacy ($r=0.763$, $p<0.05$), with a strong correlation strength; Learning Engagement was significantly positively correlated with Online Learning Self-Efficacy ($r=0.649$, $p<0.05$), with a moderate correlation strength. Similarly, the sub-dimensions of Online Presence were found to have a strong positive correlation with both engagement and student satisfaction. All latent correlations are reported in Table 3.

## 5. DISCUSSION

The findings of this investigation suggest that online presence and learning engagement play a positive role in self-efficacy functioning for PGTE students during the pandemic period. Adaptability help PGTE students better engage with new learning in an unfamiliar physical environment and an uncertain virtual learning environment. The more adaptable students are, the more positive the feedback on their academic and non-academic evaluations of themselves. Virtual education has a positive impact since the majority of PGTE remote learners have developed academic self-regulation skills, can rapidly adapt to online learning, and extensively gain expertise in online courses. Due to the convenience and comfort of online circumstances, PGTE students are more willing to join in online discussions than in the traditional classroom. The survey also shows that online student-centred learning activities could motivate students to conduct independent searches and gain their problem-solving skills.

The findings also indicate that the critical concerns for PGTE students are in the psychological and social aspects, as most PGTE learners prefer the offline system due to the negative impact of less diverse social interactions and the perceived lack of recognition from the online educational institution. Educators should help improve interaction and collaboration between students and school, increase their emotional and cognitive engagement, and help students recognise and adapt to change, novelty and uncertainty, considering the characteristics of different learners. To prevent burnout or loss of interest when studying online and keep online learning activities. Course designers could use these outcomes in course design and facilitation of learning to motivate individuals to devote more time and cognitive effort to learning, allowing students to experience a greater sense of achievement and efficacy, improving student academic outcomes in online courses.

## 6. CONCLUSIONS

This study highlights the importance of online presence and learning engagement to student self-efficacy for online model students and emphasizes the need of internal and external support for student self-regulation and psychological concerns. Increasing engagement and promoting positive social and emotional learning are undoubtedly challenges for distance learning. This study has implications for future research, theory, and practice. In the post-covid - 19 era, offline educators can offer more diverse learning programmes, adopt flexible mixing learning modules, achieve

more desirable learning styles, and create more valuable learning and social spaces to offline education. We hope to blur the boundaries between typical classroom learning and virtual learning by drawing from students and help shape mixed engineering delivery in the post-COVID era.

However, the study has potential limitations that should be noted for future research. First, the sample for this study was selected from a few universities in the United Kingdom, a random sample that might not represent all online higher education institutions worldwide. Thus, more studies on similar lines should be undertaken on students from different disciplines or degree courses. Second, we have analysed each sub-dimension separately, modelling their interdependencies without using multivariate methodologies. Future studies could consider more complex models for a more in-depth discussion.

## 7. REFERENCES

Ainley, M. and Ainley, J., 2011. Student engagement with science in early adolescence: The contribution of enjoyment to students' continuing interest in learning about science. *Contemporary Educational Psychology*, 36(1), 4-12.

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

Bandura, A., 1986. The explanatory and predictive scope of self-efficacy theory. *Journal of social and clinical psychology*, 4(3), 359.

Bourne, J., Harris, D. and Mayadas, F., 2005. Online engineering education: Learning anywhere, anytime. *Journal of Engineering Education*, 94(1),131-146.

Caskurlu, S., Maeda, Y., Richardson, J.C. and Lv, J., 2020. A meta-analysis addressing the relationship between teaching presence and students' satisfaction and learning. *Computers & Education*, 157, 103966.

Collie, R.J., Holliman, A.J. and Martin, A.J., 2017. Adaptability, engagement and academic achievement at university. *Educational Psychology*, 37(5), 632-647.

Desimone, L.M. and Le Floch, K.C., 2004. Are we asking the right questions? Using cognitive interviews to improve surveys in education research. *Educational evaluation and policy analysis*, 26(1), 1-22.

Dziuban, C.D. and Shirkey, E.C., 1974. When is a correlation matrix appropriate for factor analysis? Some decision rules. *Psychological bulletin*, 81(6), 358.

Edström, K. and Kolmos, A., 2014. PBL and CDIO: complementary models for engineering education development. *European Journal of Engineering Education,* 39(5), 539-555.

Fredricks, J.A., Blumenfeld, P.C. and Paris, A.H., 2004. School engagement: Potential of the concept, state of the evidence. *Review of educational research*, 74(1), 59-109.

Garrison, R., 2000. Theoretical challenges for distance education in the 21st century: A shift from structural to transactional issues. *International Review of Research in Open and Distributed Learning*, 1(1), 1-17.

Goman, V., 2022, January. Thermal modelling and simulation for engineering education using Simulink. In *AIP Conference Proceedings* (Vol. 2456, No. 1, p. 020013). AIP Publishing LLC.

Harper, K.C., Chen, K. and Yen, D.C., 2004. Distance learning, virtual classrooms, and teaching pedagogy in the Internet environment. *Technology in Society*, 26(4), 85-598.

Hutchison, M.A., Follman, D.K., Sumpter, M. Bodner, G.M., 2006. Factors influencing the self-efficacy beliefs of first-year engineering students. *Journal of Engineering Education*, 95(1),39-47.

Kakosimos, K.E., 2015. Example of a micro-adaptive instruction methodology for the improvement of flipped-classrooms and adaptive-learning based on advanced blended-learning tools. *Education for chemical engineers*, 12,1-11.

Lockee, B.B., 2021. Online education in the post-COVID era. *Nature Electronics*, 4(1), 5-6.

Maroco, J., Maroco, A.L., Campos, J.A.D.B. and Fredricks, J.A., 2016. University student's engagement: development of the University Student Engagement Inventory (USEI). *Psicologia: Reflexão e Crítica*, 29.

Martin, A.J., Nejad, H.G., Colmar, S. and Liem, G.A.D., 2013. Adaptability: How students' responses to uncertainty and novelty predict their academic and non-academic outcomes. J*ournal of Educational Psychology*, 105(3), 728.

Nagel, L. and Kotzé, T.G., 2010. Supersizing e-learning: What a CoI survey reveals about teaching presence in a large online class. *The Internet and Higher Education*, 13(1-2), 45-51.

Naidu, S., 2022. Reimagining and reengineering education systems for the post-COVID-19 era. *Distance Education*, 43(1),1-5.

Neuwirth, L.S., Jović, S. and Mukherji, B.R., 2021. Reimagining higher education during and post-COVID-19: Challenges and opportunities. *Journal of Adult and Continuing Education*, *27*(2), 141-156.

Roffe, I., 2002. E-learning: engagement, enhancement and execution. *Quality assurance in education*, *10*(1), pp.40-50.

Russo, T.C. and Benson, S., 2005, January. Learning with invisible others: Perceptions of online presence and their relationship to cognitive and affective learning. *International Forum of Educational Technology and Society,* January 2005.

Van Dinther, M., Dochy, F. and Segers, M., 2011. Factors affecting students' self-efficacy in higher education. *Educational research review*, 6(2), 95-108.

Vehovar, V., & Manfreda, K. L. 2008, Overview: online surveys. *The SAGE handbook of online research methods*, 1, 177-194.

Volery, T. and Lord, D., 2000. Critical success factors in online education. *International journal of educational management*.

Wang, C.H., Shannon, D.M. and Ross, M.E., 2013. Students' characteristics, self-regulated learning, technology self-efficacy, and course outcomes in online learning. *Distance Education*, 34(3), 302-323.

Zhang, Y., Tian, Y., Yao, L., Duan, C., Sun, X. and Niu, G., 2022. Individual differences matter in the effect of teaching presence on perceived learning: From the social cognitive perspective of self-regulated learning. *Computers & Education*, 104427.

Zimmerman, W.A. and Kulikowich, J.M., 2016. Online learning self-efficacy in students with and without online learning experience. *American Journal of Distance Education*, 30(3), 180-191.