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Abstract

Purpose

COVID-19 has had global repercussions on use of e-learning solutions. In order to maximise the promise of e-learning, it is necessary for managers to understand, control and avoid barriers that impact learner continuance of e-learning systems. The TIPEC framework (Ali et al., 2018) identified theoretical barriers to e-learning implementation, i.e., grouped into four theoretical concepts (7 Technology, 26 Individual, 28 Pedagogy, and 7 Enabling Conditions). This study validates the 26 theoretical individual barriers. Appreciating individual barriers will help the e-learning implementation team to better scope system requirements, and help achieve better student engagement, continuation, and ultimately success.

Design/Methodology/Approach

Data was collected from 344 e-learning students and corporate trainees, across a range of degree programs. Exploratory and confirmatory factor analysis was used to define and validate barrier themes. Comparison of results against Ali et al (2018) allow comparison of theoretical and validated compound factors.

Findings

Results of exploratory and confirmatory factor analysis combined several factors and defined 16 significant categories of barriers instead of the 26 mentioned in TIPEC Framework.

Originality / Value

Individual learner barriers, unlike technology and pedological barriers which can be directly identified and managed, appear abstract and unmanageable. This paper, considering implementation from the learner perspective, not only suggests a more simplified ontology of individual barriers, but presents empirically validated questionnaire items (see Appendix A) that can be used by implementation managers and practitioners as an instrument to highlight the barriers that impact individuals using e-learning factors. Awareness of individual barriers can help content provider to adapt system design and/or use conditions to maximize the benefits of e-learning users.

Keywords – TIPEC framework, e-learning information systems, Implementation, Individual Barriers

Introduction

Heraclitus claimed that change is the only constant in life. Since the start of the twenty-first century there has been significant change - e.g., in society, health management, economics, business management – which is driven in part by the significant technology changes that have transformed how mankind captures, stores, and disseminates information and knowledge around the globe. In an increasingly virtual world, business managers, organization leaders, and education providers are increasingly enquiring whether technology solutions can be used to effectively and efficiently support their future education needs.

Internet-based technologies have been used to support 'e-learning' since the 1960s, however tools were often limited in scope, limited in interactivity and functionality. As such numerous researchers have criticised the effectiveness of using such e-learning solutions (Ali et al, 2018); raising concerns that remote e-learning students feel secluded, e-learning students suffer in their studies due to the low levels of student-teacher interactivity, and completion and satisfaction rates for online education / training are 10-20% lower than traditional face-to-face education (Ahmady, et al. 2018).

Such findings, compounded by high upfront investment costs and cases of system implementation failure and rejection, have resulted in business managers, policy makers, and education providers defining e-learning education solutions as a poor-quality alternative to face-to-face teaching. On the of 30th January 2020, however, a paradigm shift occurred when the World Health Organization (WHO) declared the global COVID-19 pandemic. Governments around the world mandated social distancing and nationwide lockdowns, which resulted in the physical closure of educational institutes in over 50 countries. Although face-to-face teaching was stopped, the closure of educational institutions did not mean the cessation of teaching and learning activities. Throughout 2021 and 2022 business and education providers were forced to embrace e-learning solutions, since e-learning was the only viable solution to remote delivery of interactive education/training material to their staff / students. Considerable investment was made in development of e-learning solutions; since e-learning facilitate access in remote locations, by learners with unpredictable or unsociable working hours, and is visible via low-cost client technology (such a mobile phone). Accordingly, the demand for e-learning courses has grown exponentially, particularly in developing countries, and is rapidly becoming integral to the growth and success stories of education dissemination (Allen & Seaman, 2015). The global pandemic resulted in an increased adoption and use of technology mediated education, and much progress has been made to the scope and functionality of e-learning solutions, however many of the barriers that hindered pre-covid implementation success, and ultimately the learner satisfaction of e-learning programs, still threaten the long-term continuance of e-learning solutions. Literature highlights many potential barriers to e-learning system success (e.g., Kunene & Barnes, 2017; Juutinen et al., 2018; Yunus, Lubis, & Lin, 2009; Aldowah, Ghazal, & Muniandy, 2015; Panda & Mishra, 2007; Andreea & Elena, 2020; Leary & Berge, 2006; Andersson & Grönlund 2009), which really need to be identified, and effectively managed, if e-learning systems are going to continue to be used once face-to-face options return. To summarise implementation barriers Ali et al. (2018) developed the *Technology, Individual, Pedagogy and Enabling Conditions* (TIPEC) framework, which identified 68 unique theoretical barriers to e-learning implementation

success. The TIPEC framework considered research between 1999 and 2016 (i.e., 259 papers related to e-learning barriers), and thematically grouped barriers into 5 categories; i.e., Technology (7), Individual (26), Pedagogy (28) and Enabling Conditions (7). To date the TIPEC model stands as the most comprehensive theoretical framework relating to e-learning barriers (Andreea & Elena, 2020), and offers considerable support to implementation practitioners in understanding and managing the barriers that possibly prevent the successful completion and use of e-learning systems.

Technical and pedagogy barriers can be internally identified, and managed more directly by the implementation project team, however it is difficult for the project team to fully appreciate, measure, and/or manage the twenty-six {26} individual factors (e.g., limited technical ability/access, lack of confidence, and lack of motivation) which were highlighted by Ali et. al (2018) in the TIPEC framework - see figure 1. When evaluating challenges and barriers facing e-learning systems implementation, Tao et al. (2012) highlighted the importance of considering on the learner's perception; since the learner is ultimate the stakeholder who determines e-learning system success or failure. Since the student's satisfaction is key to system acceptance and retention, which is also key to e-learning system success, it is critical that educators identify the existence of individual resistance barriers. Appreciation of individual differences, such as financial constraints, external commitments, technical ability / access issues, lack of confidence, and lack of motivation, is critical to ensuring that the e-learning solution are not perceived as respectively being 'too expensive', 'too inflexible', 'too technical', 'too intimidating', or just 'not what we wanted'. Currently, however, no mechanism exists to support the implementation project team in identification of individual barriers.

Technology and Pedagogy barriers may be overcome by developing infrastructure and/or by effectively managing the development of better education content, yet the significant invest required to develop the technology and/or pedagogy quality if meaningless if the learner fails to engage with the course due to a lack of basic technical skills and/or a lack of core resources at their discretion (Anagnostopoulou et al., 2015). To date no attempt has been made to i) validate the Individual factors theoretically presented within the TIPEC framework, and/or ii) empirically validate a set of questionnaire items that can be used as an instrument to highlight the existence of individual barriers within a specific student cohort.

This paper, by capturing empirical data from the learner perspective, not only simplifies the ontology of individual barriers, but develops a set of empirically validated questionnaire items to highlight the existence of individual barriers. Validating the impact of individual factors within the TIPEC framework clarifies the list of factors that need to be considered by implementation practitioners and education managers. Development of a validated standard questions items, which flag the existence of specific barriers, will help education providers maximise the chance that critical barriers are included/considered at the project requirements analysis and planning stage.

Literature Review

Good education is significant to the development of high value human capital (Liu, Li, & McLean, 2017). As such on-going education is critical to both economic competitiveness and business productivity (British Counsil, 2012), and education management is central to ensuring a highly skilled labour force. Traditional face-to-face education has considerable physically and temporal limitations (Saleem & Gouse, 2018). For that reason, traditional education is being transformed and augmented with technology-based learning solutions (Gillet, 2013). E-learning solutions, which supports technology-based delivery and interaction with learning materials via a computer network (Zhang, Zhao, Zhou, & Nunamaker Jr, 2004), are therefore increasingly being developed for use in society and business as the most likely answer to lifelong learning and effective education. Research shows that use of technology in education, if implemented and managed well, facilitates a 'better' solution than face-to-face alone, which is more efficient (over time), more effective (supporting technology, interface, and content customization/personalization), and is not limited by the time and space over limitations of conventional learning approaches (Nnazor, 2009; Rajasingham, 2012).

The increasing demand for e-learning solutions is driving researchers and educational practitioners to better understand the antecedents that support successful e-learning implementation (Lee, Yoon, & Lee, 2009; Miliszewska, 2011). Esterhuyse & Scholtz (2015) classified e-learning barriers into five (5) dimensions - lack of resources, infrastructure issues, technical issues, organisation management, and social interaction. Sadeghi (2016) considers four e-learning issue categories - pedagogy, culture, technology, and e-practice. Gutirrez-Santiuste et al. (2016) presented four (4) students facing elearning barrier dimensions - Psychological Barriers, Sociological Barriers, Technical Barriers, and Cognitive issues. Andersson & Grönlund (2009), based on a review of 60 papers related to e-learning implementation failure, proposed a framework containing four (4) barrier dimensions: Course related issues; Individuals related issues; Technological issues; and Context related issues. Ali et. al (2018) expanded Andersson & Grönlund (2009) framework, based on a more comprehensive 259 papers from a range of countries and cultures, and proposed the TIPEC framework, which comprised of four (4) categories (Technology, Individual, Pedagogy and Enabling Conditions) containing a total of sixty-eight (68) e-learning barriers (see Figure 1). The 'Technology', 'Individual', 'Pedagogy', and 'Enabling Conditions' categories contained respectively seven (7), twenty-six (26), twenty-eight (28), and seven (7) distinct implementation barriers (see Figure 1). This TIPEC framework, to date, is the most extensive model of e-learning success antecedents, reviewing 259 papers from 26 years of research (1990 to 2016) relating to e-learning barriers. The TIPEC framework presents a theoretical conceptual understanding of e-learning implementation barriers, however the TIPEC framework is unvalidated, in part as validation of all 68 barriers is not practically possible at one time. Since the TIPEC framework is unvalidated, use of the TIPEC framework in practice to guide implementation success is ill advised (Ali, Uppal, & Gulliver, 2018). As such there is a considerable need to validate the existence of barriers, in order to promote consideration of barriers in practice.

Insert Figure 1 Here

When implementing any e-learning systems, the most important stakeholder is arguably the student, since his/her motivation and satisfaction with the system will determine the ultimate impact of the e-learning system. Since e-learning success is directly linked to student acceptance of the system, student perception of barriers is therefore important, and needs to be identified and managed throughout any e-learning systems implementation project in order to ensure that the quality of the final e-learning experience is maximized (Serban, 2019); since poor student satisfaction will lead to long-term system failure (Alshehri, 2017). Accordingly, this study aims to empirically validate, via use of a structured questionnaire, how the twenty-six (26) theoretical individual barriers are perceived by students, i.e., the primary stakeholder of the higher education system (Ali, Uppal, & Gulliver, 2018).

Understanding the TIPEC Individual Barriers

To effectively capture the student perception of 'individual' implementation barriers, it is critical that the reader fully understands the 26 individual barriers defined in the TIPEC framework (Ali, Uppal, & Gulliver, 2018). The following describes each factor in turn:

1. **Student Motivation (SM) -** Because of the autonomous nature of e-learning, one of the documented downsides for students of online working is that self-discipline and self-motivation that is critical. Unlike a traditional face-to-face class, class times vary, and individuals do not often meet at a specific day or time, which reduces the responsibility to log on and complete their work to specific deadlines (Willging & Johnson, 2004).
2. **Self-efficacy (SEf) -** Lack of confidence, whilst handling computers, is seen as a key issue for not adopting e-learning. SEf (Joo, Bong, & Choi, 2000) relates to a users' self-assessment of their ability to apply computer skills to accomplish tasks and is directly linked with the success and failure of the e-learning system (Cheng, 2011).
3. **Awareness and Attitude Towards ICT (ATICT) -** Lack of IT awareness can result in low rates of adoption because people are unaware of, or do not think positively to use of technology (Nagunwa & Lwoga, 2012; Mahmoodi-Shahrebabaki, 2014; Datuk & Ali, 2013). Findings of the study conducted by Kitchakarn (2016) stated that attitude towards the technology is an important factor in learning performance.
4. **Inequality in Access to Technology (IAT) – Hardware -** One of the important metrics of the digital divide is inequality in access to technology (Fairlie, 2004); particularly impacting developing nations. This inequality limits access to use of technology, and sometimes access to only outdated systems hinders e-learning.
5. **Individual Culture (IC) -** Students or individuals each have a unique set of beliefs, attitude and cultural norms, which plays a vital role in developing his/her attitude towards e-learning. The concept of individual culture states that each individual has a unique culture instead of a national or organizational one (Yoo, Donthu, & Lenartowicz, 2011).
6. **Perceived Usefulness and Ease of Use Perceptions (PUEOU) –** In this context perceived usefulness and ease of use relate to the users' perception concerning using an e-learning system. These perceptions have a direct impact on the students intention to use the elearning system (Davis, 1989; Venkatesh & Davis, 2000).
7. **Equality in Access to Internet Connectivity (IAIC) – Bandwidth -** Inequality in access to internet connectivity (bandwidth) is a main component for e-learning and for the lower-

class high bandwidth solutions are still unaffordable (Okine, Agbemenu, & Marfo, 2012; Farid, Ahmad, Niaz, Itmazi, & Asghar, 2014). Hardware provision is not the same thing, as low bandwidth results in low interactivity in e-learning course and etc.

8. **Students Support (StSu) -** Mavroidis et al. (2013) reported that students prefer technology mediated learning if there is strong peer and staff support. The effectiveness of the e-learning can therefore be improved if the level of student support is improved (Valkanos & Fragoulis, 2007).
9. **Social Support (SoSu) -** "Social support is conceptualized as a protective factor in students' lives that contributes to students' successful adjustment to university" (Solberg & Viliarreal, 1997). Masoumi & Lindström (2012) also mention social support as being necessary to bring students into a e-learning environmen; with effectiveness of support determining the perceived quality from the learners' perspective.
10. **Technophobia (TP) -** TP is the anxiety around future interactions with any technological component (Purushothaman & Zhou, 2014). Students who exhibiting this phobia (unlike barrier 3) are actively dismissive new technology and unwilling to use technology for the means of learning (Juutinen, Huovinen, & Yalaho, 2011; Khasawneh, 2018).
11. **Computer Anxiety (CA) -** CA is the anxiety around interaction with computers; however, some other technologies are used without concern (Powell, 2013). Learners with computer anxiety are almost totally resistant to use of e-learning (Stiller & Köster, 2016).
12. **Sense of Isolation due to reduced Face to Face Interaction (SI) -** Online it is very difficult to engage learners because face to face interaction with the learner is not always possible (Mahmoodi-Shahrebabaki, 2014; Datuk & Ali, 2013). Literature signifies that reduced face to face interaction is one of the major reasons for e-learning students dropout rates (Luo, Zhang, & Qi, 2017; Nortvig, Petersen, & Balle, 2018).
13. **Social Loafing (SL) -** Williams & Karau (1991) define social loafing as the tendency to reduce individual effort when working in groups. In e-learning social loafing exists - when undertaking groups work – since there is often limited physical checks by lecturers that all group members are delivering an equal contribution. Literature mentions that individuals will be unlikely to exert extraordinary effort unless they view their individual task within the group project as meaningful (Karau & Williams, 1993).
14. **Student's Economy (SE) -** Lack of student funding is a major reason for e-learning student dropout (Kwofie & Henten, 2011). If the ongoing financial cost of the e-learning course is high then the student may be reluctant to continue to completion.
15. **Cost of Using Technology (CUT) –** CUT similar to barrier 13, can hinder adoption of e-learning system (Gupta & Jain, 2014) if upfront cost and/or cost of use (such as licence fee) is high; particularly relevant in developing nations where students may have low incomes.
16. **Family Commitments (FC) -** A great deal of students who start e-learning courses have family commitments, which is one of the reasons they choose e-learning over traditional class room setting (McManus, Dryer, & Henning, 2017). Many studies reported, however, that many students eventually stop studying due to these commitments (Valencia-Forrester, Patrick, Webb, & Backhaus, 2019).
17. **Work Commitment (WC) -** Students with work commitment far more likely to dropout (Hack, 2016). Literature has reported that students often miss classes and deadlines due to their work commitments (Trede, Markauskaite, McEwen, & Macfarlane, 2019).

18. **Conflicting Priorities (CP) -** Hinderance in the amount of time an e-learning student has/wants to devote to the online courses – due to other personal and professional priorities – will impact dropout (Safie & Aljunid, 2013). Idachaba and Idachaba (2012) states that over-reaching e-learners feel more stressed and have big problems in arrangement of the time due to conflicting priorities.
19. **Student Readiness (SR) -** Student readiness (SR) is the student's self-perception concerning their own ability to accomplish the learning task (Khanh & Gim, 2014). SR is perceived as a catalyst to successful online learning (Kunene & Barnes, 2017).
20. **Response to Change (RC) -** Response to change is a major issue in adoption of e-learning as people find it difficult to work in a fully electronic environment (Jager & Lokman, 1999; Song & Keller, 2001). Resistance to change can therefore hinder adoption of e-learning.
21. **Technological Difficulty (TD) -** Students still face technological difficulty and consider it as a barrier in e-learning (Li & Jiang, 2017). It is the difficulty students face while operating e-learning systems. Complex design of e-learning system can also lead to hindrance in using e-learning system for students.
22. **Technology Experience (TE) -** Individual's exposure to, and experience of, learning technologies impacts the learning experience (Al-Busaidi, 2013), and has a direct impact on the learning outcome (Wan, Fang, & Neufeld, 2007). Arbaguh and Duray (2002) stated that experienced student satisfaction was greater than unexperienced student satisfaction.
23. **Computer Literacy (CL) -** Computer literacy is the declarative and procedural computer-related knowledge, familiarity with computers, and therefore self-confidence in using computers (Parlakkiliç, 2017). A low level of computer literacy will negatively affect the knowledge acquisition (Wecker, Kohnle, & Fischer, 2007).
24. **Lack of ICT Skills (LICTS) -** LICTS is arguably similar to factors 3, 22 and 23, however this factor relates to a lack of specific ICT skills / training and is not related to a lack of access, experience, a phobia or lack of self-confidence. Learners with no technical skill often get frustrated (Jarvis & Szymczyk, 2010) and were not always able to benefit or engage with e-learning opportunities (Al-Adwan & Smedley, 2012).
25. **Prior Knowledge (PK) -** Prior knowledge is referred to, by Ali. et al. (2018), as whether or not a student had exposure to the relevant material of the course. Student prior knowledge, i.e., of the subject/content, impacts e-learning success and student learning style (Akanabi & Dwyer, 1989). Use of e-learning and other technology aided learning can help the learning outcome of students with low prior knowledge (Last, O Donnell, & Kelly, 2001).
26. **Academic Confidence (AC) -** The student's academic confidence is a good predictor of a e-learning student success (Andersson, 2008).

Ali et al. hypothesized that these twenty-six (26) themed individual barriers need to be considered and/or managed in order to ensure e-learning success, however the TIPEC framework study is based on the theoretical concept theming of literature, and has not been quantitatively validated using real-world data (Ali, Uppal, & Gulliver, 2018).

Methodology

In order to validate the theoretical framework, there is a need to convert each of the individual barriers into testable instruments, in order to employ empirical observation through structured survey using a deductive approach (Petticrew, et al., 2013). The approach used for item

generation and selection during the process of questionnaire development is thus crucial (Glass & Arnkoff, 1997). We developed a bank of 85 items for the 26 individual barriers. Each item statement was developed after careful scrutiny of the recent literature relating to each of the barriers. To refine the construct items, initial lists of items was subjected to expert judgment for redundancy, content validity, clarity, and readability. This round of item assessment resulted in the elimination of (12) irrelevant items. Each of the remaining 73 question items was then examined critically for clarity and readability, and problematic items were reworded where confusion was raised.

Closed ended questions and use of self-administered structured questionnaire method was selected. A 7-point Likert Scale was used to measure feedback for each of the remaining 73 item statement, i.e., with 7 representing 'Completely Agree' and 1 representing respectively 'Completely Disagree'. Finally, the revised instrument was piloted with 30 students for additional feedback on clarity of the items. Pilot testing is very important to determine how long it takes to complete the instrument, to establish if the instructions are clear, and most importantly to identify if participants found anything objectionable, difficult, or unclear about the instrument item statements (Lackey & Wingate, 1998). The researchers analysed the results of the pilot study and identified that some of the statements were perceived as 'slightly confusing'. After making relevant changes to item statements, data collection was initialised. Respondents, due to the nature of the research, were students – from BBA, BSc, MBA, Executive MBA, and Corporate Executives degrees. In total the authors gained responses from 344 participants. This data was cleaned and entered within SPSS, to facilitate preliminary tests to consider normality, reliability, and means. In total 17 responses were discarded due to missing values, and/or normality and reliability issues; leaving 327 full responses for use in analysis.

Findings

Exploratory Factor Analysis (EFA)

The very first step, after scale development, is to check the reliability and validity of constructs and items of the scale. Initially, before performing further analysis, and in order to group items based on the strong correlations, and check both reliability and discriminant validity, Exploratory and Confirmatory Factor analysis (EFA and CFA respectively) were conducted. EFA helps screen out the problematic questionnaire items/constructs. Kaiser-Meyer-Olkin Measure of Sampling Adequacy, with Varimax rotation and Maximum likelihood extraction, was used. KMO value should be greater than 0.5 for a satisfactory factor analysis to proceed. Table 1 shows that the values of KMO and Bartlett's Test show higher strength of the relationship amongst observed factors.

Insert Table 1 Here

We started with the 73 items, linked to 26 constructs, however according to Hair et al. (2010) researchers should carefully evaluate the factor matrix for items that are loading to another

factor, or with load, with values less than 0.5. During the initial EFA iteration we found multiple cross-loadings, and low total variance. Hair et al. (2010) suggests that researchers can systematically remove problematic items, i.e., items with a low loading - less than 0.5 – and/or items that do not load.

After the removal problematic question items, a 16-factor solution model was identified (see table 2) with the cumulative total variance of 81.5%. Eigenvalues of all extracted factors were above 1; implying that extracted factors account for a large proportion of the variable's variance. The communalities for the remaining 51 question items was higher than 0.55, with most being higher than 0.8, suggesting that factor analysis is indeed reliable. Table 2 shows the rotated factor analysis exhibiting 16 extracted factors along with respective factor loading using the maximum likelihood extraction method.

Insert Table 2 Here

Confirmatory Factor Analysis (CFA)

Confirmatory factor analysis is necessary to confirm the factors that are in EFA. CFA was performed using SPSS AMOS on the 16 extracted factors / constructs. Construct validity and reliability of the 16 constructs and 51 items were tested and proved. First measure is Composite reliability (CR) it shows the internal consistency amongst all the items; to measure a single construct (Fornell & Larcker, 1981). The threshold value of CR for each single factor should be greater than 0.7. Composite reliability for all 16 constructs were above 0.8, thus confirming their reliability (see Table 4). Secondly, the construct validity is evaluated by confirming convergent and discriminant validity. Convergent validity is met when Average Variance Extracted (AVE) of the observed constructs is greater than 0.5 (Igbaria & Iivari, 1995). AVE for the 16 extracted constructs was higher than 0.5; with the majority being higher than 0.8 which confirms the convergent validity. As for the discriminant validity it is a major measure for CFA to confirm there is no multicollinearity issue in the observed model (Alarcón, Sánchez, & De Olavide, 2015). Maximum Shared Value (MSV) should be less than AVE to validate the discriminant validity, Table 3 shows that MSV for all 16 constructs is less than AVE.

Insert Table 3 Here

Model Fitness

The last step of CFA is the model fit, which is used to measure / check how well the factors in the structure correlate with the variables in the dataset. A good fit signifies that factors in the model are correct, i.e., supported by empirical data set. Table 4 presents the model fit values obtained, and the threshold of each measure (Hu & Bentler, 1999). Results suggest a good model fit; thus, confirming the observed model, which consists of 16 validated and confirmed constructs. Accordingly empirical validation of TIPEC Individual factors shows that students – in practise – combine together some of the 26 theoretical Individual barriers proposed by Ali et al. (2018), resulting in 16 distinct useable factors. See table 5, which present an alignment

between the theoretical categorisation in Ali et al. (2018) vs the results of the empirically validated model.

Insert Table 4 & 5 Here

Nine (9) out of these sixteen (16) factors are compounded themes, which were formed by combining two or more factors from the theoretical TIPEC framework. The validated factors, see table 5, facilitates a revision to the individual factors contained in the TIPEC model. Detail of these nine (9) compound factors (8 to 16 – see table 5) are also described below:

8. **Support by Peers & Society (SPS) –** TIPEC factors Social Support (SoSu) and support from the fellow students, i.e., Students Support (StSu), were combined to encompass relating to stakeholder support. To reflect inclusion of both original factors this factor was named 'Support by Peers & Society'.
9. **Computer Anxiety & Technophobia (CATP) –** Unsurprisingly items related to Computer anxiety (CA) and Technophobia (TP) cross-loaded, hence factors were combined forming a single factor entitled 'Computer Anxiety & Technophobia' (CATP).
10. **Reduced Face to Face interaction (RFI) -** Social loafing (SL) and Sense of Isolation (SI) are both impacted by reduced levels of face-to-face interaction. Based on their definitions the items we combined under a new factor entitled 'Reduced face to face interaction'.
11. **Students Finances (FE) -** Student's Economy (SE) and Cost of using Technology (CUT) were perceived as relating to a single factor, which was called 'Student finances'.
12. **Conflicting Priorities based on commitments (CPC) -** Three separate TIPEC factors, i.e., 'Work commitments' (WC), 'Family Commitments' (FC), and 'Conflicting Priorities' (CP), were combined within a single factor entitled 'Conflicting Priorities based Commitments'.
13. **Student Readiness –** Original 'Response to Change' (RC) and 'Student Readiness' (SR) items were combined within a new broader 'Student Readiness (SR) definition.
14. **Student's Technical Capability (STC) -** The factor/barriers 'Technological Difficulty' (TD) and 'Technology Experience' (TE) were combined under the term 'Student's Technical Capability' (STC). This theme covers the broader definition of the students ability and skills to use and handle the e-learning system.
15. **Computer literacy (CL) -** Question items for 'Lack of ICT skills' (LICTS) and 'Computer Literacy' (CL) were found to strongly correlate, under the new broader category 'Computer Literacy'.
16. **Academic and Experiential Relevance (AER) -** Question items from 'Academic Confidence' (AC) and 'Prior Knowledge' (PK) cross-loaded together, creating a new modified compound theme entitled 'Academic and Experiential Relevance' (AER).

Conclusion

Good education is significant to the development of high value human capital (Liu, Li, & McLean, 2017), which itself is core to effective management and organisational success. As such investment in education and through-life training is critical to both the individual learner, who aims to maximise their own potential, and to business leaders, who need to ensure that

staff continue to acquire the skills and knowledge required to maximise business performance and facilitate business evolution in light of domain, technology, and societal change. Technology facilitated education is increasingly being adopted by Higher Education Institutions (HEIs) and business organisations around the globe to facilitate self-paced training services. This shift in acceptance and use of e-learning solutions, offers considerable transformation to traditional models of teaching and learning (Caverly & MacDonald, 2003), yet individual learner barriers, if left unmanaged, risks continuance of e-learning solutions moving forward.

E-learning solutions are often perceived as a low quality alternative to face-to-face teaching models (Uppal, Ali, & Gulliver, 2018). To combat this negative perception in the future, it is important that e-learning system implementers fully consider, i.e., within requirements analysis, relevant factors that impact the learners' perception of system satisfaction, or we risk businesses, HEIs, and individuals rejecting use of e-learning solutions once face-to-face teaching options return.

Ali et al. (2018) developed the TIPEC framework by systematically reviewing literature and thematically forming a theoretical understanding of e-learning barriers that existed. The TIPEC framework categorized e-learning barriers into four (4) categories (Technology, Individual, Pedagogy and Enabling Conditions). Ali et al. (2018) identified numerous barriers / challenges that occur during e-learning implementation, yet i) the TIPEC framework was not validated against real-world data, and ii) no practical tool existed to determining the existence of specific factors in a specific student cohort. In order to practically utilise / apply the TIPEC framework in e-learning projects, validated question items were needed to empirically link statement feedback to the existence of certain failure factors. This study provides researchers, practitioners, policy makers, and other managers with a validated instrument (see appendix A) that can highlight the existence of individual barriers to use / acceptance of e-learning system.

Instrument development, testing, and validation, showed that, from the learner's perspective, there are 16 distinct and measurable barriers to e-learning use (See Appendix A); including 9 compound factors that were formulated using results of our EFA and CFA analysis. Our consolidated instrument not only support measurement and identification of failure barriers / factors within real-world projects – as the questions can be used in practice - but will also help higher education institutions in order to gain a better understanding of how systems are impacting their students at an individual level. We also hope that questions items, when asked across a range of HEI and professional service providers, across different countries, will help researcher understand which barriers are more prominent in specific cultures / countries / and organisation types.

The success of any information system is directly dependent upon the acceptance and use of its users. By using the validated items, in advance of an e-learning solution implementation, education organisations, and implementation managers, should be able to identify the presence of barrier impacting students (as individual). Since barriers can now be identified in advance of project deployment, the authors believe there is an increased likelihood that problems can be effectively managed, and that implementation problems can be more effectively avoid. As such the authors believe that questionnaire items (see Appendix A) can be used to forecast

prominent barriers to e-learning, from the perspective of the learner (users), which can be then used to define system requirements, and shape a positively enriching educational experience for all.

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Appendix A

Factor (Question Item)	
1. Student Motivation	
If the course content being taught in the class is irrelevant, it would demotivate you and hinders in e-learning. (SM_1)	0.93
If you dislike learning through e-learning technologies in the class, it would demotivate you and hinder in e-learning. (SM_2)	0.92
If you have little or no motivation towards e-learning, it would hinder use of e-learning. (SM_4)	0.91
If the e-learning class is not interesting, it would demotivate you and hinder interest in e-learning. (SM_3)	0.90
2. Self-Efficacy (SEf)	
If you are sure that that you will not be able to complete the tasks assigned for the e-learning classes, it will hinder adoption of e-learning. (SEf_3)	0.88
If you are certain that you will not understand the ideas taught in the e-learning course, it will hinder adoption of e-learning. (SEf_2)	0.84
If you think that you will not receive a good grade in the class, it will hinder adoption of e-learning (SEf_4)	0.68
3. Awareness and attitude towards ICT (ATICT)	
Absence of awareness towards e-learning systems, hinders e-learning use. (ATICT_2)	0.87
Having a negative attitude towards e-learning would hinder e-learning. (ATICT_1)	0.73
If interaction with an e-learning system is not a fun experience, it would hinder use of e-learning. (ATICT_3)	0.64
4. Inequality in Access to technology (IAT)	
Students using outdated technology can hinder e-learning (IAT_3)	0.99
Unavailability of the required e-learning technologies hinders adoption (IAT_2)	0.88
5. Individual Culture (IC)	
If e-learning system does not align to your learning style, it will hinder use of e-learning (IC_2)	0.77
Providing e-learning solutions that do not consider the student's cultural values hinders use of e-learning (IC_3)	0.72
Do you think that student's personal expectation hinders e-learning? (IC_1)	0.69
6. Perceived usefulness and ease of use perceptions (PUEOU)	
I find it easy to get the e-learning system to do what I want it to do. (PUEOU_5)	0.89
Using the e-learning system will allow me to accomplish learning tasks more efficiently. (PUEOU_3)	0.75
The use of an e-Learning system within a module improves my learning performance. (PUEOU_1)	0.48
7. Inequality in access to internet connectivity (IAIC)	
Low bandwidth internet connection hinders e-learning. (IAIC_3)	0.90
Does problems accessing the internet hinder e-learning. (IAIC_1)	0.83
8. Support by Peers & Society (SPS)	
No support from fellow students will hinder use of e-learning. (StSu_4)	0.93
Inability to contact instructors when necessary, hinders my use of e-learning. (StSu_3)	0.92
I get enough support via e-learning systems to manage my student affairs. (StSu_1)	0.91
No organizational support towards e-learning hinders use of e-learning. (SoSu_2)	0.90
Having non-conducive environment during e-learning sessions hinders use of e-learning. (SoSu_3)	0.90
9. Computer Anxiety & Technophobia (CATP)	
Feeling scared of working with the latest technologies hinders use of e-learning. (TP_2)	0.92
Feeling afraid of operating new systems hinders use of e-learning. (TP_1)	0.91

Nervousness about using e-learning is a barrier to use of e-learning. (CA_1)	0.90
E-learning systems being intimidating is a barrier to e-learning. (CA_3)	0.88
10. Reduced Face to Face Interaction (RFI)	
Does having less or no interaction amongst students hinder e-learning. (SL_2)	0.95
Does having less or no interaction between student and teacher hinder e-learning. (SL_1)	0.93
Absence of Physical meetings with instructor is a barrier to e-learning use. (SI_1)	0.77
Feeling of isolation during e-learning sessions hinders e-learning use. (SI_3)	0.75
11. Student Finances (SF)	
Financial cost of undertaking the e-learning course hinders adoption of e-learning. (SE_1)	0.94
Having limited funds would hinder my access to e-learning. (SE_2)	0.94
If the cost of technological components required in e-learning is high, it will hinder e-learning (CUT_2)	0.91
12. Conflicting Priorities based on Commitments (CPC)	
If family commitment takes up most of your time and resources, it hinders use of e-learning (FC_1)	0.92
Conflicts in an individual's priorities, due to undertaking an e-learning course, hinders e-learning use. (CP_2)	0.92
Absence from the exam and late submission of assignments, due to job commitments, can hinder your use of e-learning (WC_2)	0.91
13. Student Readiness (SR)	
Unwillingness to learn through e-learning, hinders adoption e-learning (SR_1)	0.96
If you are not ready for an e-learning course, it hinders your adoption of e-learning (SR_2)	0.93
Resistance to change, e.g., from the existing educational system to the new tools of e-learning, hinders adoption of e-learning (RC_2)	0.90
14. Students Technical Capability (STC)	
Being unable to solve technical problems might hinder use of e-learning. (TE_3)	0.94
Difficulty in operating e-learning systems hinders intention to use e-learning. (TD_1)	0.92
Lacking of technology experience will stop me completing e-learning tasks. (TE_2)	0.90
15. Computer Literacy (CL)	
Having less or no skills to operate technology hinders in e-learning. (LICTS_2)	0.94
If you do not possess adequate computer skills, it will hinder adoption of e-learning. (LICTS_1)	0.89
Little or no knowledge about computers will hinder the e-learning experience. (CL_2)	0.87
16. Academic and Experiential Relevance (AER)	
Having no academic experience related to the e-learning course would hinder adoption of e-learning (AC_2)	0.91
Not having relevant academic qualification hinders adoption of e-learning. (AC_1)	0.89
Do you think having no background knowledge related to the course content would hinder in e-learning? (PK_2)	0.87

Table 1 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.786
Bartlett's Test of Sphericity	Approx. Chi-Square	1625.9
	Df	1275
	Sig.	.000

Table 2 Rotated Component Matrix (Maximum Likelihood Extraction)

Items	Factor															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SM_1	0.93															
SM_2	0.92															
SM_4	0.91															
SM_3	0.90															
SEf_3		0.88														
Sef_2		0.84														
Sef_4		0.68														
ATICT_2			0.87													
ATICT_1			0.73													
ATICT_3			0.64													
IAT_3				0.99												
IAT_2				0.88												
IC_2					0.77											
IC_3					0.72											
IC_1					0.69											
PUEOU_5						0.89										
PUEOU_3						0.75										
PUEOU_1						0.48										
IAIC_3							0.90									
IAIC_1							0.83									
StSu_4								0.93								
StSu_3								0.92								
StSu_1								0.91								
SoSu_2								0.90								
SoSu_3								0.90								
TP_2									0.92							
TP_1									0.91							
CA_1									0.90							
CA_3									0.88							
SL_2										0.95						
SL_1										0.93						
SI_1										0.77						
SI_3										0.75						
SE_1											0.94					
SE_2											0.94					

CUT_2											0.91					
FC_1												0.92				
CP_2												0.92				
WC_2												0.91				
SR_1													0.96			
SR_2													0.93			
RC_2													0.90			
TE_3														0.94		
TD_1														0.92		
TE_2														0.90		
LICTS_2															0.94	
LICTS_1															0.89	
CL_2															0.87	
AC_2																0.91
AC_1																0.89
PK_2																0.87

Table 3 Construct Validity and Reliability

	CR	AVE	MSV	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Factor 1	0.96	0.85	0.03	**0.92**															
Factor 2	0.88	0.71	0.15	-0.01	**0.84**														
Factor 3	0.82	0.60	0.11	0.03	0.20	**0.77**													
Factor 4	0.94	0.89	0.01	0.10	0.07	0.08	**0.94**												
Factor 5	0.79	0.56	0.06	0.10	0.23	0.14	0.11	**0.75**											
Factor 6	0.78	0.56	0.06	0.03	0.20	0.18	-0.02	0.12	**0.75**										
Factor 7	0.96	0.92	0.03	0.02	0.04	0.17	-0.09	0.17	0.07	**0.96**									
Factor 8	0.97	0.86	0.06	-0.01	0.15	0.12	-0.05	0.09	0.24	0.08	**0.93**								
Factor 9	0.95	0.84	0.03	0.00	0.18	0.12	0.09	0.14	0.00	0.09	0.14	**0.91**							
Factor 10	0.93	0.76	0.04	-0.02	0.17	0.19	-0.04	0.05	0.12	0.07	0.19	0.15	**0.87**						
Factor 11	0.97	0.91	0.07	0.17	0.20	0.16	0.04	0.22	0.17	0.07	0.07	0.08	0.14	**0.95**					
Factor 12	0.96	0.90	0.11	0.02	0.23	0.17	0.05	0.25	0.13	0.10	0.04	0.12	0.15	0.16	**0.95**				
Factor 13	0.96	0.90	0.06	0.07	0.13	0.15	0.08	0.20	0.05	0.19	-0.03	0.12	0.02	0.16	0.24	**0.95**			
Factor 14	0.96	0.89	0.11	0.11	0.10	0.33	0.01	0.22	0.05	0.06	0.01	-0.06	0.05	0.12	0.12	0.08	**0.94**		
Factor 15	0.94	0.85	0.05	0.05	0.16	0.19	0.10	0.16	0.16	0.13	0.12	0.10	0.14	0.11	0.10	0.17	0.23	**0.92**	
Factor 16	0.96	0.89	0.15	0.08	0.39	0.11	0.08	0.21	0.21	0.04	0.21	0.09	0.21	0.27	0.34	0.08	0.04	0.11	**0.94**

Table 4 Measures of Model Fitness

Measures	Values	Threshold
CMIN/DF(χ^2/df)	1.58	< 3 good
Confirmatory Fit Index (CFI)	0.96	> 0.90
Adjusted Goodness of Fit Index (AGFI)	0.80	> 0.80
Standardized Root Mean Square Residual (SRMR)	0.05	< 0.09
Root Mean Squared Error of Approximation (RMSEA)	0.04	< 0.05 good, 0.05 – 0.10 moderate

Table 5 TIPEC Orginial Theorized Factors vs Validated Factors after EFA & CFA

Individual Factors- TIPEC Framework (Ali et. al 2018)		Individual Factors- Validated Current Study (2020)	
1	Student Motivation (SM)	Factor 1	Student Motivation (SM)
2	Self-efficacy (SEf)	Factor 2	Self-Efficacy (SEf)
3	Awareness and Attitude Towards ICT (ATICT)	Factor 3	Awareness and attitude towards ICT (ATICT)
4	Inequality in Access to Technology (IAT)	Factor 4	Inequality in Access to technology (IAT)
5	Individual Culture (IC)	Factor 5	Individual Culture (IC)
6	Perceived Usefulness and Ease of Use Perceptions (PUEOU)	Factor 6	Perceived usefulness and ease of use perceptions (PUEOU)
7	Inequality in Access to Internet Connectivity (IAIC)	Factor 7	Inequality in access to internet connectivity (IAIC)
8	Students Support (StSu)	Factor 8	Support by Peers & Society (SPS)
9	Social Support (SoSu)		
10	Technophobia (TP)	Factor 9	Computer anxiety & Technophobia (CATP)
11	Computer Anxiety (CA)		
12	Sense of Isolation due less Face to Face Interaction (SI)	Factor 10	Reduced Face to Face interaction (RFI)
13	Social Loafing (SL)		
14	Student's Economy (SE)	Factor 11	Students Finances (SF)
15	Cost of Using Technology (CUT)		
16	Family Commitments (FC)	Factor 12	Conflicting Priorities based on Commitments (CPC)
17	Work Commitment (WC)		
18	Conflicting Priorities (CP)		
19	Student Readiness (SR)	Factor 13	Student Readiness (SR)
20	Response to Change (RC)		
21	Technological Difficulty (TD)	Factor 14	Student's Technical Capability (STC)
22	Technology Experience (TE)		
23	Computer Literacy (CL)	Factor 15	Computer literacy (CL)
24	Lack of ICT Skills (LICTS)		
25	Prior Knowledge (PK)	Factor 16	Academic and Experiential Relevance (AER)
26	Academic Confidence (AC)		

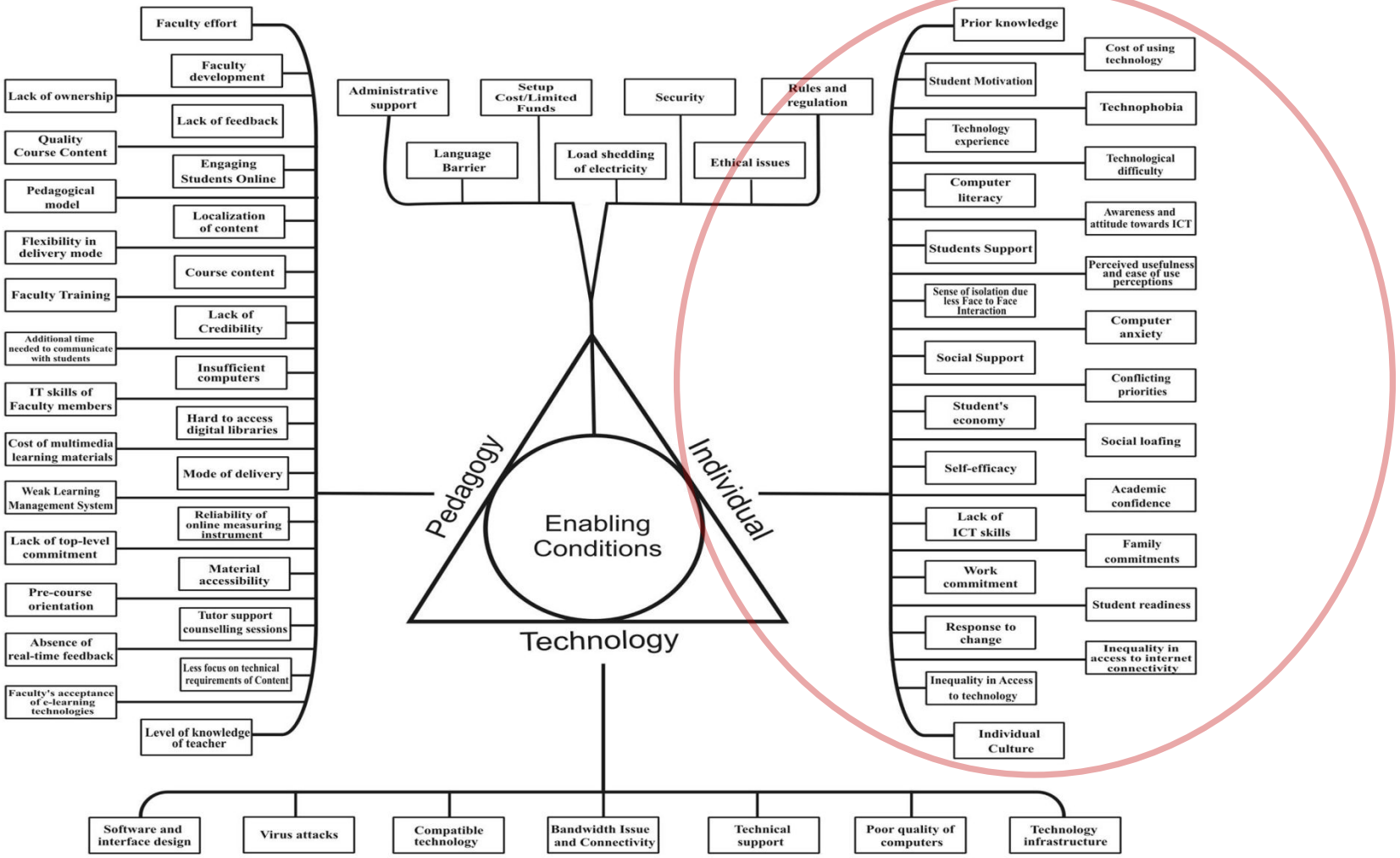

Figure 1. 68 issues in TIPEC framework *(Ali, Uppal, & Gulliver, 2018)*. **Individual issue highlighted**