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Evaluating student satisfaction with online hackathon for IT projects

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Abstract

Hackathons are growing more virtual, especially after the COVID-19 epidemic started since they attract many participants at once from different places and time zones. This study intends to identify factors that influence students' satisfaction with online hackathon for IT projects. The study used quantitative methodology and proposed a model. The model was developed using technology acceptance model variables (perceived usefulness [PU], perceived ease of use [PEOU], behavioral intention [BI]) in combination with self-efficacy (SE) and satisfaction variables. The study questionnaire was distributed to 180 university students who have participated in a hackathon. The results were measured for reliability and validity (Cronbach's alpha was used for reliability while confirmatory factor analysis was used for validity. The hypothesis in the suggested model were assessed using structural equation modeling technique. The results show that BI and PEOU have no influence on students' satisfaction with using online hackathon for IT projects. However, it was discovered that students' satisfaction with online hackathon for IT projects is influenced by PU and SE. These findings imply that creating online courses that participants perceive as useful and see themselves as having high SE in their projects will further enhance satisfaction with online hackathons. It might also encourage and facilitate the use of online hackathons among students. Universities should routinely provide instruction and advice to students to help them understand the advantages of online courses. In summary, the research will be useful to decision-makers and educators in universities to further the integration of online hackathons for IT projects in the curriculum. Future recommendations should consider the use of additional technology adoption variables as well as testing the data with a qualitative methodology.

Keywords: IT projects, online hackathon, COVID-19, technology acceptance model, SEM, self-efficacy, satisfaction

INTRODUCTION

In recent years, an increasingly common method of education is online learning due to its flexibility and accessibility. Particularly widespread are online courses in the information technology (IT) curriculum, where students can acquire technical skills without the need for a physical classroom. The constraints posed by the worldwide pandemic made the hybrid mode of work plausible. The academic community was not left behind as it had to formulate new ways of imparting knowledge to continue serving the needs of learners (Mendes et al., 2022). This required educational institutions to transition to an online learning environment or better known as emergency remote teaching while balancing learners' and teachers' needs without creating excessive friction for users who are just trying to do their tasks (Lyons et al., 2021). However, online courses have some limitations, such as the lack of physical interaction and hands-on experience. To overcome these limitations, many institutions organize online hackathon, which provide students with the opportunity to work on real-world projects and collaborate with their peers. They utilized the use of smart applications or e-learning tools like mobile devices and smart phones for conducting the learning process. This includes mobile games,

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Contribution to the literature

- The investigation of the impact of variables like as perceived usefulness, perceived ease of use, behavioural intention, and self-efficacy advances our understanding of the factors that contribute to online hackathon satisfaction.
- The findings that perceived usefulness and self-efficacy strongly influence students' satisfaction are valuable for institutions trying to include online hackathons into their curricula to effectively engage students, particularly in the context of distant and virtual learning environments.
- The findings of this study can be used by educators and instructional designers to construct useful online courses that raise students' self-efficacy, hence increasing their sense of satisfaction and engagement.

simulations, and gamification. Virtual tutoring, digital libraries, videoconferencing technologies like Zoom, and learning management systems are some regular eLearning tools (Alassafi, 2022).

These smart applications are increasingly used to raise student learning motivation, promote student engagement, and increase learning sustainability (Wiggins, 2016) more effectively. For instance, Almaiah et al. (2022) reports Saudi universities were ready to implement mobile learning applications in their study if they were ready to use m-learning system. In Indonesian private schools, Natasia et al. (2022) reports teachers' readiness and positive attitude towards NUADU platform in the learning process that meet the national curriculum. Moreover, Bailey et al. (2022) provide evidence from the viewpoint of the students on the degree of continued use of Zoom video conferencing systems for instruction in the post-COVID-19 era. They suggested that before video conference software was used in classrooms, teachers and students should have received thorough training on how to use it. According to Aldossry (2021) review, the Madrasati Platform will be the new entry point for all Saudi education beginning in 2020 for online teaching and learning.

Given the different platforms available to include students in the learning process, online idea competitions are being used to tap into the creativity, talent, and brainpower of millions of online users (Faas et al., 2019; Gama et al., 2021). This would enable interaction with other students who have similar interests, establishing relationships and a feeling of community while addressing environmental, social, or professional concerns (Granados & Pareja-Eastaway, 2019; Terwiesch & Xu, 2008). Students can compete for prizes while working together, having discussions, exchanging insights, and learning from the collective wisdom and comments of others (Gama et al., 2018). There is an increasing demand for research on the topic of hackathon since they are generally acknowledged as a source of innovation and because there is still a dearth of literature discussing how hackathon work and how they help students come up with ideas, especially for online hackathon (Happonen et al., 2021; Oyetade et al., 2022).

Therefore, this study aims to answer the research question–What factors influence students' satisfaction with online hackathon for IT project? The objectives of the research are to determine the factors influencing students' satisfaction with online hackathon for IT project as well as develop and empirically test the online hackathon model.

RELATED WORKS

Hackathons are programming contests, where competitors work together on a chosen project to create usable products (Flus & Hurst, 2021; William et al., 2021). While most hackathons have themes with numerous areas of focus, some organizers may assign participants a specific issue to resolve. The skill sets of the organizers and the significant resources they must devote to the event's organization, execution, and follow-up determine the length, scope, and format of a hackathon (Franco et al., 2022; Medina Angarita & Nolte, 2020). Hackathons provide students with the opportunity to develop technical skills, collaborate with peers, and apply theoretical knowledge to practical problems.

Hackathons have been utilized as an alternative learning environment for students to perfect new skills (Fowler, 2016; Nandi & Mandernach, 2016) with reports that some teachers were using these occasions as part of scheduled class activities (Horton et al., 2018; Porras et al., 2018; Uys, 2020). It's thought that using it as an educational tool could help students practice the four capacities of experiential learning (Kolb, 2014). The experiential, interactive, and multiple interactions with knowledgeable mentors and facilitators are the main goals of these events. They are increasingly being utilized to include students in group projects across a variety of academic disciplines. At these events, participants will collaborate and form working teams with the intention of producing concept solutions within the allocated time with formal presentations of the solutions, which are then assessed according to their viability or other factors (Gama et al., 2018; Lyons et al., 2021). Like any curricular or pedagogical approach, it is crucial that the rationale for a hackathon be known before the logistics are considered.

Table 1. Some of the organized online hackathons events

Author	Purpose	Goal	Date	Country	Digital platform used
Affia et al. (2022)	Online cybersecurity course	Address online education issues	N/A	N/A	Online videos & instructions
Allan et al. (2022)	Social change & health improvement	Youth ideas & innovations to address impacts of COVID-19 pandemic	November 4-December 18 2020	Philippines	Facebook, Twitter, & social innovation in health initiative's official website
Braune et al. (2021)	Remote online health hackathon	Solving challenges & effects of a pandemic in several regions of the world	April 20, 2020	Germany	N/A
Brereton (2020)	EU vs. virus project	Remote working & education challenge	April 24 -26, 2020	Europe	Slack, Devpost, & Facebook
Buchem and Leiba (2022)	DigiEduHack2021 (digital education)	Online hackathon as a collaborative & inclusive instructional design approach	N/A	Europe	Slack, DigiEduHack2021 platform, Zoom, Google Meet or WhatsApp, Google Drive, Google Forms, Microsoft PowerPoint, Axure, Figma, & SurveyMonkey
Fadlelmola et al. (2021)	African genomic medicine & microbiome	Develop data portals for African microbiomes & genomic medicine	April 2019-June 2020	Africa	Django, Python; CSS & web programming, Java, C++, MySQL, & GitHub
Gama (2020)	MPLabs COVID-19 challenge	Development of pandemic solutions that might be put into effect immediately	March 17-20, 2020	Brazil	N/A
Gama et al. (2021)	Development of semester project	Continuously engaged in synchronous group work	November 19-23, 2020	N/A	Discord, Google Meet, & Slack
Lyons et al. (2021)	DigiEduHack2020	Reimagine education & develop real-world solutions to advance goal of digital education ecosystem	November 9-10, 2020	Europe	Slack, Facebook, Twitter, Zoom, YouTube, & WhatsApp
Maldonado-Romo and Yeh (2022)	Impact of quantum computing in Latin America	Generating educational resources in Spanish	N/A	Mexico & Latin America	Facebook, Discord, Twitter, LinkedIn, WhatsApp, & Slack
Powell et al. (2021)	Online hackathons for newcomers in a scientific community	Experience programming first-hand in a collaborative environment	N/A	N/A	Google Form, Github, Webinar, Google Cloud, Zoom, Slack, Discord, Facebook Messenger, iMessage, Teams, & others
Ribault et al. (2022)	Neurorehabilitation (hacking rehab Lyon)	Innovation in healthcare	October 5-7 2020	N/A	Dedicated website & social networks
Steglich et al. (2021)	Students acquiring core professional skills	Encourage professional development of software engineering students	N/A	N/A	Discord, WhatsApp, GitHub, Google Drive, Jamboard, Trello's virtual boards, Figma tool, Photoshop, React, HTML with CSS, & VSCode

Originally a physical event, hackathons are becoming increasingly virtual, especially since the COVID-19 epidemic began as they draw large numbers of participants simultaneously from various locations and time zones. This trend is being driven by the emergence of the platform economy, which is promoting improvements in online visibility, interactions, networking structures, and digital collaborations and provides students with practical and hands-on experience, which can be beneficial in preparing them for their future careers (Acciarini et al., 2022; Bolici et al., 2020). Vermicelli et al. (2021) reports that COVID-19-related issues are the focus of numerous online hackathons. In education, these events focus on universities in several instances (Hossain et al., 2020; William et al., 2021). However, in a classroom or course setting, there is not, however, a precise use (Goodman & Radu, 2020). In any case, there are several online hackathons that are organized around different themes, objectives, and sizes to crowdsource solutions to issues (**Table 1**).

Online events are expected to continue due to their special advantages even though in-person hackathons are becoming more common again following the return to normalcy after the pandemic (Mendes et al., 2022). Online hackathons, for instance, might encourage participation by people who cannot go to a hackathon location owing to a lack of finances or probable visarelated challenges and allow for a speedy setup (Mendes et al., 2022; William et al., 2021).

The factors that influence online hackathon adoption may differ from those that influence the adoption of traditional educational technology. It is necessary to find what factors influence student satisfaction (SS) with the use of online hackathon for participants.

Hackathons are a unique form of technology that requires collaboration and participation from multiple stakeholders. With the benefits of technology accessibility and the positive attitude about hackathon use, it is difficult to refute the premise that technology is continuously improving education. As the study examines the role and purposes of online hackathons and discovers how they foster teamwork and creativity among students taking an IT project. It follows that the technology acceptance model (TAM) satisfaction model is a model that will help the study determine how students would accept and implement online hackathon in IT projects. This is because TAM developed by Davis (1989) to explain computer usage behavior has achieved wide acceptance and been validated by numerous empirical studies as an accurate predictor of system usage and acceptance (Isaac et al., 2018). Despite this acceptance, it neglects to focus on evaluating technology usage, such as user satisfaction. Therefore, the purpose of this study is to propose and verify that TAM can be employed to explain and predict online hackathons among students by extending TAM with two factors, namely self-efficacy (SE), and user satisfaction. This is in line with other study on TAM that examined whether TAM is a reliable indicator of user satisfaction with IT in settings, where usage is required and found it significant (Han & Sa, 2022; Mather et al., 2002).

CONCEPTUAL MODEL DEVELOPMENT

This section seeks to give a general introduction of TAM framework and how it is used to research SS in an online IT project hackathon.

TAM Overview and Its Application to the Study

TAM is a widely used theoretical framework for explaining how users adopt and use technology (Venkatesh & Davis, 2000). In the context of online education, TAM can be used to research students' acceptance and use of educational technology and how some TAM variables influence satisfaction. According to TAM, perceived usefulness (PU) and perceived ease of use (PEOU) are significant determinants of users' attitudes towards technology, which in turn affects their desire to use the technology (Davis, 1989; Ping & Liu, 2020). The guiding premise of this model states that when a user is given instructions on how to use new technology, several factors may influence their decision. In the context of online hackathon, PU refers to the degree to which students believe that the technology employed in the course improves their learning results. On the other hand, PEOU describes how much a student thinks technology is simple to use and understand. Numerous studies have utilized TAM framework to study SS in online courses. For example, Anthony et al. (2022) used TAM to investigate the factors that influence students' satisfaction with a blended learning course. The results showed that PU and PEOU significantly influenced students' attitudes towards the course and their satisfaction with it. Similarly, Tawafak et al. (2020) used TAM to study the factors that influence students' satisfaction with a massive open online course (MOOC). The results showed that PU and PEOU significantly influenced students' satisfaction with MOOC.

In addition to TAM, other factors such as flexibility of online learning, computer expertise, usefulness of online learning have also been found to influence SS in online courses (Ismail & Mack, 2008; Karim et al., 2021). These factors may interact with TAM constructs and influence students' attitudes towards the technology used in the course. TAM can be a useful framework for understanding why students may or may not participate in the event and how satisfied they are with the experience. To apply TAM in this context, specific technology being used for the online hackathon would need to be identified (e.g., a coding platform, a video conferencing tool, etc.) and gather data on students' perceived usability and utility. This data can be collected through surveys, interviews, or observation of participants during the event. Academics frequently utilize TAM to assess e-learning systems since it is arguably the most significant theoretical contribution to adoption research. Since hackathon is a form of technology that involves collaboration of stakeholders, the current study placed places emphasis on the following five factors: SE, PEOU, PU, SS, and behavioral intention (BI), as shown in **Figure 1**. The study outcome will assist decision makers and stakeholders in coming

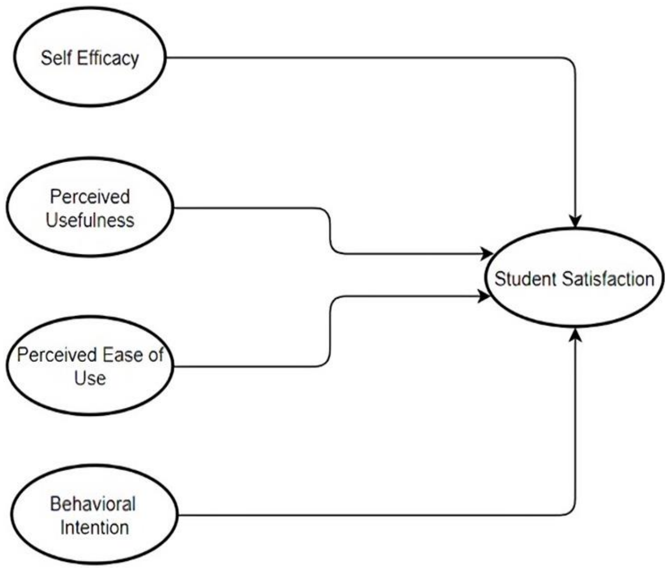

Figure 1. Proposed online hackathon model (Source: Authors' own elaboration)

up with suitable policies regarding the issues of online mode of learning.

Proposed Model and Hypothesis Development

By gathering data on the identified constructs, one can gain insight into students' perceptions of the online hackathon and how it can be improved to increase satisfaction and participation. The data can also be used to compare the effectiveness of different technologies and strategies for promoting student engagement in IT courses.

Self-efficacy

SE is the belief that one can complete a task and reach a goal (Bandura, 1977). The likelihood that students will use online learning platforms as a learning mode has been proven to be significantly impacted by it (Liaw & Huang, 2013). Several studies have revealed a connection between students' levels of SE and increased learning outcomes and behavioral retention and that students are more likely to participate and engage in hackathons (Byrne et al., 2017; Kienzler & Fontanesi, 2017; Szymanska et al., 2020). Online hackathons provide students with opportunities to develop technical skills, collaborate with peers, and apply theoretical knowledge to practical problems, which can enhance students' SE. Research has also suggested that SE is positively related to students' motivation and confidence in their ability to succeed in online learning (Byrne et al., 2017; Lee & Mendlinger, 2011; Liaw, 2008). Students who have increased SE are more likely to set objectives and try to achieve them, leading to increased engagement and motivation. Moreover, research has shown that hackathons can help to develop students' SE by providing them with opportunities to learn and apply new skills in a supportive and collaborative environment (Kienzler & Fontanesi, 2017; Szymanska et al., 2020). The feedback and guidance provided by instructors and peers during online hackathons can also enhance students' SE by boosting their confidence in their abilities. Higher levels of SE in students increase their likelihood of participating and engaging in online hackathons for IT projects, which can help them with opportunities to learn and apply new skills in a supportive and collaborative environment. In conclusion, SE is an important factor in determining students' intention to use online hackathons for IT projects.

H1. SE significantly influences students' satisfaction with online hackathon for IT projects.

Perceived usefulness

The degree to which users believe a technology will improve their performance, productivity, or goal-achieving is known as PU (Davis, 1989). Studies have shown that PU and students' satisfaction with online learning systems are positively correlated (Ares Albirru et al., 2021; Lee & Mendlinger, 2011). It has been found to significantly impact learners' motivation, engagement, and learning outcomes (Haddad, 2018; Venkatesh et al., 2003). In education, it is a critical factor in technology acceptance and adoption and relates to how strongly students feel that taking part in the online hackathon would help them reach their objectives or develop their skills. This construct is closely related to utility, which refers to the practical value that users derive from the use of technology (Venkatesh et al., 2003). In e-learning, PU is critical in ensuring that learners perceive the technology as relevant and valuable to their learning experience (Haddad, 2018). To assess this, you could ask students questions such as "How useful do you think participating in the online hackathon will be for improving your coding skills or help you achieve your career goals?" Online hackathons have gained popularity in recent years as a means of providing students with hands-on experience in real-world problem-solving with PU of hackathons found to have a big impact on whether or not students intend to employ this form of learning to accomplish their learning objectives (Maaravi & Heller, 2021; Oyetade et al., 2022). Furthermore, PU of online hackathon can impact students' engagement and motivation to participate in these events (Lee & Mendlinger, 2011; Oyetade et al., 2023). When students perceive online hackathons as useful, they are more likely to be motivated to participate and engage in the learning activities provided by hackathon.

H2. PU significantly influences students' satisfaction with online hackathon for IT projects.

Perceived ease of use

PEOU is the extent to which consumers think a technology is simple to use and needs little effort (Davis, 1989). It is a key determinant of technology acceptance and use has been identified as an important factor influencing students' intention to use online hackathons as a mode of learning in the field of education. Studies have shown that PEOU and students' satisfaction with online learning systems are positively correlated (Al-Rahmi et al., 2015; Lee & Mendlinger, 2011; Ohliati & Abbas, 2019). PEOU has been found to have a significant influence on learners' motivation and engagement (Ohliati & Abbas, 2019; Venkatesh et al., 2003). To assess this, you could ask students questions such as "how easy was it for you to navigate the coding platform used during the online hackathon?" or "did you encounter any technical difficulties during the online hackathon?" Students who find online hackathons easy to use are more likely to have a positive learning experience and report higher levels of satisfaction with the platform. PEOU is an important determinant of students' intention to use online hackathons as a mode of learning. When online hackathons are perceived as easy to use, students are more likely to engage with them and have a positive learning experience. Also, they are more likely to develop a positive attitude towards using them and engage in learning activities offered by these platforms.

H3. PEOU significantly influences students' satisfaction with online hackathon for IT projects.

Behavioral intention

BI refers to an individual's perceived likelihood or willingness to engage in a specific behavior, such as using a particular technology to support their learning (Ajzen, 1991). This refers to students' intention to use the technology used for the online hackathon as a mode of learning in the future. Identified as an important predictor of students' intention to use online hackathons, it is a key factor that influences SS with online learning systems. To assess this, you could ask students questions such as "how likely are you to use the coding platform used during the online hackathon in the future?" or "would you recommend this technology to others?" Studies have consistently shown that there is a positive relationship between BI and technological acceptance, including in the context of education (Venkatesh et al., 2003). Studies have shown that BI and students' satisfaction with online learning systems are positively correlated (Davis, 1989; Venkatesh et al., 2003). When students have a strong intention to use a technology, they are more likely to engage in the learning activities offered by these platforms and have a positive learning experience (Al Kurdi et al., 2020; Budu et al., 2018; Liaw, 2008). Also, students who intend to utilize technology more frequently are more likely to see its advantages, such as improved accessibility and flexibility, which raises their happiness with the educational process (Al Kurdi et al., 2020). In addition, a person's behavior and intention to use technology might be influenced by the perspectives and behaviors of peers, teachers, and family members (Teo, 2009).

Moreover, research has suggested that BI is influenced by factors such as PU, PEOU, and SE (Alassafi, 2022; Al-Okaily et al., 2020; Amin et al., 2015). When students perceive online hackathons as useful and easy to use and have a high level of SE in using the platform, they are more likely to develop a positive attitude towards using them and have a stronger intention to use them for learning. Furthermore, studies have found that students' BI to use hackathons is positively related to their actual use of the platform (Maaravi & Heller, 2021; Oyetade et al., 2023). This suggests that BI is an important predictor of students' actual engagement with online hackathons and their use as a mode of learning. When students have a strong intention to use the platform, they are more likely to engage in the learning activities offered by the platform and have a positive learning experience.

H4. BI significantly influences students' satisfaction with online hackathon for IT project.

Satisfaction

Online technologies have become an integral part of higher education as they provide a collaborative and interactive learning environment, and their impact on SS has been widely studied. SS is a key factor in determining the quality of education and its effectiveness. Research has consistently shown that online technologies can have a positive impact on SS (Al-Fraihat et al., 2020; Giray, 2021; Gopal et al., 2021). Online technologies provide students with greater access to course materials, improved communication with instructors and peers, and greater flexibility in terms of time and location (Prifti, 2022; Sun et al., 2008). Students who use online technologies to supplement their learning are more likely to report higher levels of satisfaction with their learning experience (Gopal et al., 2021). Online hackathons have been found in several studies to improve SS (Affia et al., 2022; Buchem and Leiba, 2022). Online hackathons provide students with the opportunity to engage in real-world problem-solving, work collaboratively with peers, and develop technical skills. Students who participate in online hackathons report higher levels of satisfaction with their learning experience (Ribault et al., 2022).

Research has also shown that students' intention to use online hackathons is positively influenced by factors such as PU of this mode of learning (Affia et al., 2022; Buchem & Leiba, 2022; Rocha Estrada et al., 2022). If the online hackathon platform is difficult to use or has technical issues, it can negatively impact SS and students' intention to use it in the future. The design and functionality of the platform should be intuitive and user-friendly (Rocha Estrada et al., 2022). However, it is important to note that not all students may be interested in or suited to online hackathons for IT projects as students who are new to online technologies may require additional support and guidance to feel comfortable and satisfied with the learning experience (Al-Fraihat et al., 2020). In conclusion, online systems such as the online hackathon platform have the potential to positively impact SS and intention to use this mode of learning. However, their effectiveness depends on several factors, including students' PU and ease of use, as well as their individual learning preferences.

RESEARCH METHODOLOGY

Study Design

Data was collected using an online survey in the current study to collect information from students learning IT using a quantitative research approach and a questionnaire. Convenience sampling, a sample technique that involves including study participants

Table 2. Research variables

Factors	Acronym	Items	References
Perceived usefulness	PU	5	Venkatesh et al. (2003)
Self-efficacy	SE	4	Abd Ghani et al. (2017)
Perceived ease of use	PEOU	4	Venkatesh et al. (2003)
Behavioral intention	BI	4	Venkatesh et al. (2003)
Student satisfaction	SS	3	Al-Fraihat et al. (2020)

from a target group who are simple for researchers to reach, was used (HR & Aithal, 2022). ICT students from South African universities of technology made up the population. The online system was only accessible to students who had already registered for the semester. All responses were anonymous, and to prevent double submissions, respondents were only allowed to complete the survey once. The targeted sample for this study consisted of 219 university students, but only 180 completed questionnaire. Due to their incompleteness, 39 participant replies were excluded from the study. Table 2 provides information about the 180 students.

Research Instrument

Based on TAM model modification in Han and Sa (2022), Table 2 offers five variables that are evaluated on a five-point Likert scale from "strongly disagree" (1) to "strongly agree" (5).

DATA ANALYSIS AND RESULT

The data were analyzed using means and standard deviations to calculate the parameters of normal distributions using the Jamovi software program, version 2.2.31. Frequencies and percentages to describe the respondents' demographic attributes. To determine if the factor structure can be duplicated in the new dataset from 180 university students, the confirmatory factor analysis (CFA) was used. To assess the goodness-of-fit (GOF) of the model with the provided dataset, several model fit indices and their associated criteria were utilized GFI, NFI, TLI, CFI, SRMR, NFI PGFI, and RMSEA. Following a model fit assessment, we determined construct reliability (CR) for convergent validity and average variance extracted (AVE) for discriminant validity to ensure the values exceed the minimum criteria (Bagozzi & Yi, 1988; Fornell & Larcker, 1981; Hair et al., 2013). Cronbach's alpha was used to assess each factor's dependability, and it was higher than the required threshold of internal consistency of 0.7 (Nunnally & Bernstein, 1994). Additionally, structural equation modeling (SEM) was used to evaluate the validity of each hypothesis. It also evaluated the validity and reliability of the measurement model, which were assessed to ensure good overall measurement model fit as measured by GOF statistics. GOF model's overall performance was assessed to see if it met the standards established to signify a satisfactory model fit: the goodness-of fit index (GFI>0.90) (Jöreskog & Sörbom, 1982), the norm fit index (NFI>0.80) (Bentler & Bonett, 1980), the Tucker-Lewis Index (TLI>0.90) (Tucker & Lewis, 1973), the comparative fit index (CFI>0.90) (Byrne & van de Vijver, 2010), standardized root mean square residual (SRMR) (Hu & Bentler, 1999) ,and the root mean square error of approximation (RMSEA) (Steiger, 1990).

Table 3. Demographic profile

Category		n	Percentage
Gender	Male	108	60.0
	Female	72	40.0
Age	16-20	26	14.4
	21-25	128	71.1
	26-30	21	11.7
	Above 30	5	2.8
Computer usage	Daily	74	41.1
	Weekly	75	41.7
	Monthly	15	8.3
	Fortnightly	9	5.0
	None	7	3.9
Education level	Year 1	55	30.6
	Year 2	65	36.1
	Year 3	41	22.8
	Year 4	19	10.6

Demographic Profile of Respondents

The demographics of the study can be seen in Table 3, where most of the views are skewed to male (60.0%) to those students aged between 21 and 25 years (71.1%) and they use the computers regularly: daily and weekly (82.8%). The academic level of the students who took part in the study is almost uniformly distributed. Most students believe they are prepared to use online learning platforms since they are in IT department and use computers regularly.

CFA Model Assessment

Before CFA was conducted, the assumptions for normal distribution were tested and the data fulfilled the normal assumptions CFA aids in evaluating GOF by comparing the correlational structure of the data set to a suggested structure. GOF indices for CFA model are CFI=0.939, TLI=0.927, GFI=0.990, SRMR=0.052, NFI=0.956, and RMSEA=0.0705. To guarantee that the model is considered as a sign of good fit, a CFI value higher than 0.90 is required. The study's value of 0.939 denotes a suitable fit. Good RMSEA readings are less than 0.05. As a result, the sample's RMSEA score of 0.052 suggests a good fit. GFI index, which measures how well the proposed model fits the data from this sample's observed covariance matrix, is 0.990, with a value of over 0.90 generally indicating good model fit. The study's findings show an adequate fit for the model since other fit indices, NFI and TLI, need to be higher than 0.80 for a satisfactory match. Table 4 also provides factor loadings

Table 4. Confirmatory factor analysis output

Factor	Items	Factor loading	AVE	CR	Cronbach's alpha
Perceived usefulness	PU1	0.87	0.758	0.926	0.884
	PU2	0.89			
	PU3	0.90			
	PU4	0.82			
Self-efficacy	SE2	0.93	0.684	0.866	0.829
	SE3	0.80			
	SE4	0.74			
Perceived ease of use	PEOU1	0.72	0.686	0.896	0.852
	PEOU2	0.73			
	PEOU3	0.94			
	PEOU4	0.90			
Behavioral intention	BI1	0.89	0.825	0.949	0.920
	BI2	0.92			
	BI3	0.95			
	BI4	0.87			
Student satisfaction	SS1	0.93	0.748	0.898	0.834
	SS2	0.73			
	SS3	0.92			

Table 5. Structural equation modeling output

Hypothesis	Dep	Pred	Estimate	SE	β	z	p	Outcome
H1	Satisfaction	Self-efficacy	0.2418	0.0996	0.2289	2.427	0.015	Supported
H2	Satisfaction	Perceived usefulness	0.2027	0.0776	0.2054	2.611	0.009	Supported
H3	Satisfaction	Perceived ease of use	-0.0252	0.0670	-0.0248	-0.376	0.707	Rejected
H4	Satisfaction	Behavioral intention	0.1224	0.0962	0.1291	1.272	0.203	Rejected

and CRs for convergent validity. For good convergent validity, factor loadings and CR should be more than 0.70. Hence, all the items in this study exceeded the recommended value showing sufficient convergent validity. AVE of each factor in **Table 4** helps assess the discriminant validity of this model, which should be more than 0.50 for acceptable discriminant validity. The study's findings demonstrate values larger than 0.60, indicating good discriminant validity. Cronbach's alpha is one of the most well-known internal consistency estimations and shown in **Table 4** displays Cronbach's alpha to verify the accuracy of each factor's measuring tool. Internal consistency is typically considered to be strong or exceptional if it is between 0.70 and 0.90. With values greater than 0.80, all retrieved components show strong internal consistency.

Structural Model Assessment

The structural model evaluates the hypothesized associations to support how an online hackathon might be used to measure SS. Before SEM was conducted, the assumptions for normal distribution were tested and the data fulfilled the normal assumptions. The conceptual model was tested using SEM after CFA measurement model had been assessed for fitness and the strength and direction of the association between the constructs had been established. The model was first assessed for GOF, and the values are listed as CFI=1.00, TLI=1.00, GFI=0.995, and NFI=0.994 demonstrating an adequate measurement model. To guarantee that the model is considered as a sign of good fit, a CFI value higher than .90 is required. The study's value of 1.0 denotes an acceptable fit. GFI, which measures how well the proposed model fits the data from this sample's observed covariance matrix, is 0.990, with the study's value of over 0.995 generally indicating good model fit. The study's findings demonstrate an adequate fit for the model since the other fit indices, NFI and TLI, need to be higher than 0.8 for a satisfactory match. These fit indices demonstrate that the proposed model and the observed data are well-fit and determined to be within acceptable bounds as suggested by earlier research. As a result, it was now possible to use maximum likelihood (ML) as a parameter to examine the path coefficients of the structural model. The outcomes of the study hypotheses tested in the research model to determine the association between students' satisfaction in an IT course using an online hackathon are shown in **Table 5** and **Figure 2**.

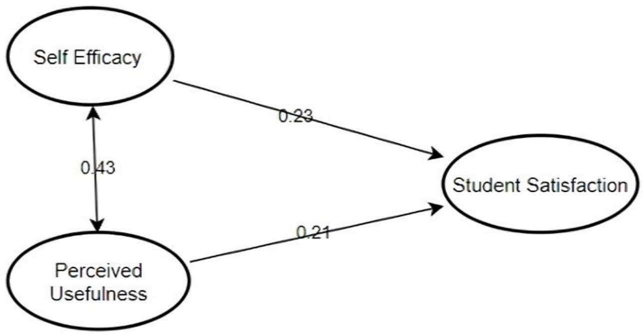

Figure 2. Final model result (Source: Authors' own elaboration)

Hypothesis 1 examined whether SE significantly influences students' satisfaction with online hackathon for IT projects. The result found that SE has a significant influence on satisfaction with a β-value of 0.2289 ($p<0.05$). Therefore, hypothesis 1 was supported.

Hypothesis 2 examined whether PU significantly influences students' satisfaction with online hackathon for IT projects. The result found that PU has a significant influence on satisfaction with a β-value of 0.2054 ($p<0.05$). Therefore, hypothesis 2 was supported.

Hypothesis 3 examined whether PEOU significantly influence students' satisfaction with online hackathon for IT projects. The result found that PEOU has a non-significant influence on satisfaction with a β-value of 0.0248 ($p>0.05$). Therefore, hypothesis 3 was rejected.

Hypothesis 4 examined whether BI significantly influences students' satisfaction with online hackathon for IT projects. The result found that BI has a non-significant influence on satisfaction with β-value of 0.1291 ($p>0.05$). Therefore, hypothesis 4 was rejected.

DISCUSSION

A conceptual model was proposed in this study to determine the factors that influence students' satisfaction in an online hackathon for IT project. It also proposed how these factors had a relationship with SS. SEM model was used to objectively evaluate the perceptual data gathered from the students. The factors from TAM were integrated with SE and SS in the hypothetical model to determine the factors that influence SS. The study reveals digital gap still exist amongst genders as the view skewed towards males who have participated in hackathons. There needs to be more initiatives and engagements to encourage more females to participates in digital activities. Given that most respondents are young individuals (aged between 21 and 25), it may be assumed that incorporating the use of online hackathon for IT projects will be easy and will lead to higher SE since they are focused and have higher cognitive ability to retain information when participating in hackathon. The results of the survey provided strong empirical support for two hypotheses (PU & SE) of the four hypothesized relationships between the constructs except PEOU and BI factor. Except for PEOU and BI factors, two of the four hypothesized relationships between the constructs (PU & SE) offered significant empirical evidence.

According to the survey's findings, SE was the largest factor determining students' satisfaction and has a very strong and significant relationship with online hackathon for IT projects. This is encouraging because students' aptitude for using an online hackathon is unquestionably one of the most significant markers of profit for both students and universities when evaluating the worth. This is encouraging because, students' aptitude for using online hackathons is unquestionably one of the most crucial indicators of benefit for both students and universities of online hackathon. The outcome of this study supports the findings of Abdallah and Abdallah (2022), which reports that students' satisfaction with e-learning was boosted by SE. These results suggested that the utilization of the e-learning system can be enhanced if the students possess enough computer abilities and a healthy predisposition to randomly communicate with the e-learning system. Additionally, Al-Fraihat et al. (2020) research on the impact of SE on satisfaction also supported the study's findings.

PU, which was the second-largest factor, was also found to have a very strong and significant relationship with students' satisfaction with online hackathon in IT projects. This is because usefulness is undeniably beneficial for both students and institutions when evaluating the worth of online hackathon (Haddad, 2018; Maaravi & Heller, 2021). The results demonstrate the value of online hackathons and the growing adoption of technology by students as a learning tool. This is consistent with past research, which indicates that PU has a statistically significant beneficial impact on educational satisfaction (Abdallah & Abdallah, 2022; Karim et al., 2021; Oyetade et al., 2022). While Landrum and Prybutok (2004) asserted that PU has a very substantial influence on satisfaction, Bhattacherjee (2001) showed that online banking customers' perceptions of usefulness had a positive influence their satisfaction. According to Karim (2011), usefulness has an impact on consumers' online buying satisfaction. In conclusion, educators should aim to design systems that align with learners' individual needs and preferences, while providing high-quality and relevant learning content. The quality and functionality of the technology used for online hackathons should also be carefully considered to ensure that learners perceive the technology as useful and valuable to their learning experience. The quality of the learning content, the level of interaction with instructors and peers, and the relevance of the hackathon to students' academic and career goals are all factors that can influence students' PU of online hackathons.

Furthermore, our research revealed that PEOU has a nonsignificant impact on SS. The results differ from those of a prior study by Abdallah and Abdallah (2022), which found that students' satisfaction with eLearning was influenced by PEOU. It appears that students' perceptions of exerting little to no effort when using hackathon system do not affect their degree of satisfaction. One explanation for these findings is that most university students already have strong technological skills, making it simple for them to pick up any new system. This may result in students not feeling all that appreciative about learning the features and functionalities of a new system. According to Agrebi and Jallais (2015), user satisfaction was favorably influenced by PEOU in a study on smartphone purchases. PEOU has been linked to higher user satisfaction in several earlier research (George & Kumar, 2013; Ohliati & Abbas, 2019). However, this study found a non-significant relationship with SS. Thus, **H3** was not supported. Designing user-friendly e-learning platforms with clear feedback and instructions should be a goal for educators. Quality of technology used in e-learning should also be considered to ensure that learners have a positive experience and are motivated to continue using the system.

After examining the impact of BI on SS (**H4**), the study concluded that BI had no positive impact on students' satisfaction. The perceived willingness or openness of students to engage in a certain behavior, such as leveraging the technology behind an online hackathon to assist their learning, does not appear to affect their level of satisfaction. It is impossible to overstate the value of objectivity in the usage of modern technologies (Davis, 1989). However, this study found a non-significant relationship with SS. Thus, **H4** was not supported. Educators should aim to design e-learning systems that are perceived as useful and easy to use to increase learners' intention to use them. Peers, instructors, and family members can also be influential in shaping learners' BI to use technology in education.

Due to students' PU and SE ideas, it's possible that learning will continue to use online resources in combination with traditional classroom settings until the right programs and tools are put in place for ease of use of these online systems as students who find online hackathons easy to use are more likely to have a positive learning experience and report higher levels of satisfaction with the platform. Also, when students have a strong intention to use technology, they are more likely to engage in the learning activities offered by these platforms and have a positive learning experience. The study places significance on structural equation analysis' main contribution to the development of academic methodologies. The model is accurate and reliable based on model validity and measurement items.

CONCLUSIONS

This study integrated TAM with two other variables SE and SS to develop an online hackathon model that could be used to explain why students are satisfied with using online hackathons for IT projects. SEM and path coefficient correlation were used to test the validity of this model. The study found that PU and SE were the main variables that influence students' satisfaction with online hackathons for IT projects. This study is comparable to one by Han and Sa (2022) who found that PU of online courses had a favorable impact on academic satisfaction. The benefit results of this study were in line with earlier studies on the utilization of hackathons by university students in the context of software engineering education (Porras et al., 2019), open innovation and crowdsourcing (Temiz, 2021), IT programming (Oyetade et al., 2022), marketing education (Calco & Veeck, 2015), and health education (Kienzler & Fontanesi, 2017). This study strengthened the importance of understanding students' satisfaction with online hackathon for IT project and contributed to the body of knowledge in this area. Hackathons are one method to ensure that higher education is more future-ready for the demands of the twenty-first century learners as they allow educators to place a higher emphasis on collaborative team-teaching, active and participative learning, and creative method for the growth of academic and cognitive skills. Hence, educators develop curricula and implement strategies to increase the use of online hackathons while also serving as a beneficial direction for further study. The need for educators to be more knowledgeable about how to maximize the pedagogical potential of new online and hybrid learning settings will increase as the demand for this curricular innovation seems to be expanding as well as invite educators to experiment with this new methodology to go against the grain of established academic norms for today's students to become more imaginative, enterprising, and future graduates who are prepared for the workplace of tomorrow. There is likely to be increased attention given to how new digital technologies can be used to support mass pedagogy and more efficient and automated forms of teaching, learning and assessment. The employment of new digital technologies to promote mass pedagogy and more effective and automated teaching, learning, and evaluation methods is likely to receive increasing attention in the future. Therefore, policy makers and educators need to consider the benefits of online hackathons to further the integration of online hackathons in the curriculum. The university's administration is encouraged to set up the necessary infrastructure for platforms using online technology.

For online hackathons to significantly boost the level of online interaction, future study should investigate integrating fundamental 4IR technologies (such as virtual reality, augmented reality, and digital twins) to expand the potential for interactions between teachers and students that will improve learners' satisfaction with online courses.

Research Limitations

Future research is made possible by the study's limitations. Firstly, students from universities made up the study's participants. Therefore, the research should be extended to high school students and other levels of education who have participated in hackathons to generalize the study's findings and see whether the results can be replicated. Secondly, the quantitative methodology utilized in this study focused on collecting data from closed-ended questions, limiting the depth of understanding. It is important to follow up the study with qualitative research to confirm the result.

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Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

REFERENCES

Abd Ghani, M., Rahi, S., Yasin, N. M., & Alnaser, F. (2017). Adoption of internet banking: extending the role of technology acceptance model (TAM) with e-customer service and customer satisfaction. *World Applied Sciences Journal, 35*, 1918-1929.

Abdallah, N., & Abdallah, O. (2022). Investigating factors affecting students' satisfaction with e-learning: An empirical case study. *Journal of Educators Online, 19*(1). https://doi.org/10.9743/JEO.2022.19.1.3

Acciarini, C., Borelli, F., Capo, F., Cappa, F., & Sarrocco, C. (2022). Can digitalization favor the emergence of innovative and sustainable business models? A qualitative exploration in the automotive sector. *Journal of Strategy and Management, 15*, 335-352. https://doi.org/10.1108/JSMA-02-2021-0033

Affia, A.-A. O., Nolte, A., & Matulevicius, R. (2022). Integrating hackathons into an online cybersecurity course. In *Proceedings of the ACM/IEEE 44th International Conference on Software Engineering: Software Engineering Education and Training* (pp. 134-145). https://doi.org/10.1145/3510456.3514151

Agrebi, S., & Jallais, J. (2015). Explain the intention to use smartphones for mobile shopping. *Journal of Retailing and Consumer Services, 22*, 16-23. https://doi.org/10.1016/j.jretconser.2014.09.003

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*, 179-211. https://doi.org/10.1016/0749-5978(91)90020-T

Al Kurdi, B., Alshurideh, M., Salloum, S., Obeidat, Z., & Al-Dweeri, R. (2020). *An empirical investigation into examination of factors influencing university students' behavior towards e-learning acceptance using SEM approach*. International Association of Online Engineering. https://doi.org/10.3991/ijim.v14i02.11115

Alassafi, M. O. (2022). E-learning intention material using TAM: A case study. *Materials Today: Proceedings, 61*, 873-877. https://doi.org/10.1016/j.matpr.2021.09.457

Aldossry, B. (2021). Evaluating the Madrasati platform for the virtual classroom in Saudi Arabian education during the time of COVID-19 pandemic. *European Journal of Open Education E-learning Studies, 6*(1), 89-99. https://doi.org/10.46827/ejoe.v6i1.3620

Al-Fraihat, D., Joy, M., Masa'deh, R. E., & Sinclair, J. (2020). Evaluating e-learning systems success: An empirical study. *Computers in Human Behavior, 102*, 67-86. https://doi.org/10.1016/j.chb.2019.08.004

Allan, U., Jana Deborah, M.-A., Meredith, L., Noel, J., Abigail Ruth, M., Joseph, D. T., Weiming, T., Mallika, A., & Po-Lin, C. (2022). Youth social innovation during the COVID-19 pandemic in the Philippines: A quantitative and qualitative descriptive analyses from a crowdsourcing open call and online hackathon. *BMJ Innovations, 8*, 161. https://doi.org/10.1136/bmjinnov-2021-000887

Almaiah, M. A., Al-Otaibi, S., Lutfi, A., Almomani, O., Awajan, A., Alsaaidah, A., Alrawad, M., & Awad, A. B. (2022). Employing the TAM model to investigate the readiness of m-learning system usage using SEM technique. *Electronics, 11*(8), 1259. https://doi.org/10.3390/electronics11081259

Al-Okaily, M., Alqudah, H., Matar, A., Lutfi, A., & Taamneh, A. (2020). Impact of COVID-19 pandemic on acceptance of e-learning system in Jordan: A case of transforming the traditional education systems. *Humanities social Sciences Review, 6*, 840-851. https://doi.org/10.18510/hssr.2020.8483

Al-Rahmi, W. M., Othman, M. S., & Yusuf, L. M. (2015). Exploring the factors that affect student satisfaction through using e-learning in Malaysian higher education institutions. *Mediterranean Journal of Social Sciences, 6*, 299. https://doi.org/10.5901/mjss.2015.v6n4s1p299

Amin, M. K., Akter, A., Azhar, A., & Akter, S. (2015). Applying TAM to understand students' behavioral Intention to use e-learning system: An empirical evidence from Bangladesh. In *Proceedings of the 18th International Conference on Computer and Information Technology* (pp. 25-26).

Anthony, B., Kamaludin, A., Romli, A., Raffei, A. F. M., Phon, D. N. A. L. E., Abdullah, A., & Ming, G. L. (2022). Blended learning adoption and implementation in higher education: A theoretical and systematic review. *Technology, Knowledge and Learning, 27*, 531-578. https://doi.org/10.1007/s10758-020-09477-z

Ares Albirru, A., Siska Lusia, P., Febri, R., & Mellyna Eka Yan, F. (2021). Perceived satisfaction and perceived usefulness of e-learning: The role of interactive learning and social influence. In *Proceedings of the 3rd*

International Conference on Educational Development and Quality Assurance (pp. 535-541).

Bagozzi, R. P., & Yi, Y. (1988). On the evaluation of structural equation models. *Journal of the Academy of Marketing Science, 16*, 74-94. https://doi.org/10.1007/BF02723327

Bailey, D. R., Almusharraf, N., & Almusharraf, A. (2022). Video conferencing in the e-learning context: Explaining learning outcome with the technology acceptance model. *Education and Information Technologies, 27*, 7679-7698. https://doi.org/10.1007/s10639-022-10949-1

Bentler, P. M., & Bonett, D. G. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin, 88*, 588. https://doi.org/10.1037/0033-2909.88.3.588

Bhattacherjee, A. (2001). Understanding information systems continuance: An expectation-confirmation model. *MIS Quarterly, 25*, 351-370. https://doi.org/10.2307/3250921

Bolici, F., Acciarini, C., Marchegiani, L., & Pirolo, L. (2020). Innovation diffusion in tourism: how information about blockchain is exchanged and characterized on twitter. *The TQM Journal*. https://doi.org/10.1108/TQM-01-2020-0016

Bollen, K. A. (1990). Overall fit in covariance structure models: Two types of sample size effects. *Psychological Bulletin, 107*, 256. https://doi.org/10.1037/0033-2909.107.2.256

Braune, K., Rojas, P.-D., Hofferbert, J., Valera Sosa, A., Lebedev, A., Balzer, F., Thun, S., Lieber, S., Kirchberger, V., & Poncette, A.-S. (2021). Interdisciplinary online hackathons as an approach to combat the COVID-19 pandemic: Case study. *Journal of Medical Internet Research, 23*, e25283. https://doi.org/10.2196/25283

Brereton, B. (2020). EU vs. virus hackathon project: A case study from a mentor's perspective. *All Ireland Journal of Higher Education, 12*.

Buchem, I., & Leiba, M. (2022). Online hackathon as an instructional design approach to student engagement and international collaboration during COVID19. A case study of a hackathon challenge at the DIGIEDUHACK 2021. In *Proceedings of the INTED 2022* (pp. 8642-8650). IATED. https://doi.org/10.21125/inted.2022.2237

Budu, K. W. A., Yinping, M., & Mireku, K. K. (2018). Investigating the effect of behavioral intention on e-learning systems usage: Empirical study on tertiary education institutions in Ghana. *Mediterranean Journal of Social Sciences, 9*, 201. https://doi.org/10.2478/mjss-2018-0062

Byrne, B. M., & Van de Vijver, F. J. R. (2010). Testing for measurement and structural equivalence in large-scale cross-cultural studies: Addressing the issue of nonequivalence. *International Journal of Testing, 10*, 107-132. https://doi.org/10.1080/15305051003637306

Byrne, J. R., O'Sullivan, K., & Sulliva, K. (2017). An IoT and wearable technology hackathon for promoting careers in computer science. *IEEE Transactions on Education, 60*, 50-58. https://doi.org/10.1109/TE.2016.2626252

Calco, M., & Veeck, A. (2015). The markathon: Adapting the hackathon model for an introductory marketing class project. *Marketing Education Review, 25*, 33-38. https://doi.org/10.1080/10528008.2015.999600

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*, 319-340. https://doi.org/10.2307/249008

Faas, T., Liu, I.-C., Dombrowski, L., & Miller, A. D. (2019). Jam today, jam tomorrow: Learning in online game jams. In *Proceedings of the ACM on Human-Computer Interaction* (pp. 1-27). https://doi.org/10.1145/3361121

Fadlelmola, F. M., Ghedira, K., Hamdi, Y., Hanachi, M., Radouani, F., Allali, I., Kiran, A., Zass, L., Alsayed, N., Fassatoui, M., Samtal, C., Ahmed, S., da Rocha, J., Chaqsare, S., Sallam, R. M., Chaouch, M., Farahat, M., Ssekagiri, A., Parker, Z., Adil, M., Turkson, M., Benchaalia, A., Benkahla, A., Panji, S., Kassim, S., Souiai, O., & Mulder, N. (2021). H3ABioNet genomic medicine and microbiome data portals hackathon proceedings. *Database, 2021*, baab016. https://doi.org/10.1093/database/baab016

Flus, M., & Hurst, A. (2021). Design at hackathons: New opportunities for design research. *Design Science, 7*, e4. https://doi.org/10.1017/dsj.2021.1

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*, 39-50. https://doi.org/10.2307/3151312

Fowler, A. (2016). Informal stem learning in game jams, hackathons and game creation events. In *Proceedings of the International Conference on Game Jams, Hackathons, and Game Creation Events* (pp. 38-41). https://doi.org/10.1145/2897167.2897179

Franco, S., Presenza, A., & Petruzzelli, A. M. (2022). Boosting innovative business ideas through hackathons. The "hack for travel" case study. *European Journal of Innovation Management, 25*, 413-431. https://doi.org/10.1108/EJIM-06-2021-0300

Gama, K. (2020). Successful models of hackathons and innovation contests to crowdsource rapid responses to COVID-19. *Digital Government: Research Practice, 2*, 1-7. https://doi.org/10.1145/3431806

Gama, K., Alencar Goncalves, B., & Alessio, P. (2018). Hackathons in the formal learning process. In *Proceedings of the 23rd Annual ACM Conference on*

Innovation and Technology in Computer Science Education (pp. 248-253). https://doi.org/10.1145/3197091.3197138

Gama, K., Zimmerle, C., & Rossi, P. (2021). Online hackathons as an engaging tool to promote group work in emergency remote learning. In *Proceedings of the 26th ACM Conference on Innovation and Technology in Computer Science Education V* (pp. 345-351). https://doi.org/10.1145/3430665.3456312

George, A., & Kumar, G. S. G. (2013). Antecedents of customer satisfaction in internet banking: Technology acceptance model (TAM) redefined. *Global Business Review, 14*, 627-638. https://doi.org/10.1177/0972150913501602

Giray, G. (2021). An assessment of student satisfaction with e-learning: An empirical study with computer and software engineering undergraduate students in Turkey under pandemic conditions. *Education and Information Technologies, 26*, 6651-6673. https://doi.org/10.1007/s10639-021-10454-x

Goodman, T., & Radu, A.-I. (2020). Learn-apply-reinforce/share learning: Hackathons and CTFs as general pedagogic tools in higher education, and their applicability to distance learning. *arXiv preprint arXiv, 04226*. https://doi.org/10.2139/ssrn.3637823

Gopal, R., Singh, V., & Aggarwal, A. (2021). Impact of online classes on the satisfaction and performance of students during the pandemic period of COVID 19. *Education and Information Technologies, 26*, 6923-6947. https://doi.org/10.1007/s10639-021-10523-1

Granados, C., & Pareja-Eastaway, M. (2019). How do collaborative practices contribute to innovation in large organizations? The case of hackathons. *Innovation, 21*, 487-505. https://doi.org/10.1080/14479338.2019.1585190

Haddad, F. S. (2018). Examining the effect of learning management system quality and perceived usefulness on student's satisfaction. *Journal of Theoretical Applied Information Technology, 96*, 8034-8044.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2013). Partial least squares structural equation modeling: Rigorous applications, better results and higher acceptance. *Long Range Planning, 46*, 1-12. https://doi.org/10.1016/j.lrp.2013.01.001

Han, J.-H., & Sa, H. J. (2022). Acceptance of and satisfaction with online educational classes through the technology acceptance model (TAM): The COVID-19 situation in Korea. *Asia Pacific Education Review, 23*, 403-415. https://doi.org/10.1007/s12564-021-09716-7

Happonen, A., Tikka, M., & Usmani, U. A. (2021). A systematic review for organizing hackathons and code camps in COVID-19 like times: Literature in demand to understand online hackathons and event result continuation. In *Proceedings of the 2021 International Conference on Data and Software Engineering* (pp. 1-6). https://doi.org/10.1109/ICoDSE53690.2021.9648459

Horton, P. A., Jordan, S. S., Weiner, S., & Lande, M. (2018). Project-based learning among engineering students during short-form hackathon events. In *Proceedings of the 2018 ASEE Annual Conference & Exposition*. https://doi.org/10.18260/1-2--30901

Hossain, F., Elmer, N., Srinivasan, M., & Andral, A. (2020). Accelerating applications for planned NASA satellite missions: A new paradigm of virtual hackathons during a pandemic and in the post-pandemic era. *Bulletin of the American Meteorological Society, 101*, E1544-E1554. https://doi.org/10.1175/BAMS-D-20-0167.1

HR, G. & Aithal, P. (2022). Deriving right sample size and choosing an appropriate sampling technique to select samples from the research population during Ph.D. program in India. *International Journal of Applied Engineering Management Letters, 6*, 288-306. https://doi.org/10.47992/IJAEML.2581.7000.0159

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*, 1-55. https://doi.org/10.1080/10705519909540118

Isaac, O., Abdullah, Z., Ramayah, T., Mutahar, A. M., & Alrajawy, I. (2018). Integrating user satisfaction and performance impact with technology acceptance model (TAM) to examine the internet usage within organizations in Yemen. *Asian Journal of Information Technology, 17*, 60-78.

Ismail, S., & Mack, S. (2008). Considering students' perceptions: The distance education student satisfaction model. *Journal of Educational Technology & Society, 11*, 216-223.

James, L. R., Mulaik, S. A., & Brett, J. M. (1983). *Causal analysis: Assumptions, models, and data*. SAGE.

Jöreskog, K. G., & Sörbom, D. (1982). Recent developments in structural equation modeling. *Journal of Marketing Research, 19*, 404-416. https://doi.org/10.2307/3151714

Karim, A. J. (2011). Evaluating the influence of reliability, usability, usefulness and website design on the satisfaction of online consumers. *Research Journal of Economics, Business ICT, 2*(2011), 28-32.

Karim, M. W., Haque, A., Ulfy, M. A., & Hossin, M. S. (2021). Factors influencing student satisfaction towards distance learning apps during the coronavirus (COVID-19) pandemic in Malaysia. *International Journal of Academic Research in Progressive Education Development*. https://doi.org/10.6007/IJARPED/v10-i2/9546

Kienzler, H., & Fontanesi, C. (2017). Learning through inquiry: A global health hackathon. *Teaching in Higher Education, 22*, 129-142. https://doi.org/10.1080/13562517.2016.1221805

Kline, R. B. (2010). Promise and pitfalls of structural equation modeling in gifted research. In B. Thompson, & R. F. Subotnik (Eds.), *Methodologies for conducting research on giftedness* (pp. 147-169). American Psychological Association. https://doi.org/10.1037/12079-007

Kolb, D. A. (2014). *Experiential learning: Experience as the source of learning and development*. FT Press.

Landrum, H., & Prybutok, V. R. (2004). A service quality and success model for the information service industry. *European Journal of Operational Research, 156*, 628-642. https://doi.org/10.1016/S0377-2217(03)00125-5

Lee, J.-W., & Mendlinger, S. (2011). Perceived self-efficacy and its effect on online learning acceptance and student satisfaction. *Journal of Service Science Management Science, 4*, 243. https://doi.org/10.4236/jssm.2011.43029

Liaw, S.-S. (2008). Investigating students' perceived satisfaction, behavioral intention, and effectiveness of e-learning: A case study of the Blackboard system. *Computers & Education, 51*, 864-873. https://doi.org/10.1016/j.compedu.2007.09.005

Liaw, S.-S., & Huang, H.-M. (2013). Perceived satisfaction, perceived usefulness and interactive learning environments as predictors to self-regulation in e-learning environments. *Computers & Education, 60*, 14-24. https://doi.org/10.1016/j.compedu.2012.07.015

Lyons, R., Brown, M., & Donlon, E. (2021). Moving the hackathon online: Reimagining pedagogy for the digital age. *Distance Education in China, 7*, 1-18.

Maaravi, Y., & Heller, B. (2021). Digital innovation in times of crisis: How mashups improve quality of education. *Sustainability, 13*. https://doi.org/10.3390/su13137082

Maldonado-Romo, A., & Yeh, L. (2022). Quantum computing online workshops and hackathon for Spanish speakers: A case study. In *Proceedings of the 2022 IEEE International Conference on Quantum Computing and Engineering* (pp. 709-717). https://doi.org/10.1109/QCE53715.2022.00096

Mather, D., Caputi, P., & Jayasuriya, R. (2002). Is the technology acceptance model a valid model of user satisfaction of information technology in environments where usage is mandatory? *ACIS Proceedings, 49*.

Medina Angarita, M. A., & Nolte, A. (2020). What do we know about hackathon outcomes and how to support them?–A systematic literature review. In A. Nolte, C. Alvarez, R. Hishiyama, I.-A. Chounta, M. J. Rodriguez-Triana, & T. Inoue (Eds.), *Collaboration technologies and social computing* (pp. 50-64). Springer. https://doi.org/10.1007/978-3-030-58157-2_4

Mendes, W., Richard, A., Tillo, T.-K., Pinto, G., Gama, K., & Nolte, A. (2022). Socio-technical constraints and affordances of virtual collaboration–A study of four online hackathons. In *Proceedings of the ACM on Human-Computer Interaction* (pp. 1-32). ACM. https://doi.org/10.1145/3555221

Nandi, A., & Mandernach, M. (2016). Hackathons as an informal learning platform. In *Proceedings of the 47th ACM Technical Symposium on Computing Science Education* (pp. 346-351). ACM. https://doi.org/10.1145/2839509.2844590

Natasia, S. R., Wiranti, Y. T., & Parastika, A. (2022). Acceptance analysis of NUADU as e-learning platform using the technology acceptance model (TAM) approach. *Procedia Computer Science, 197*, 512-520. https://doi.org/10.1016/j.procs.2021.12.168

Nunnally, B., & Bernstein, I. (1994). *Psychometric theory*. Oxford Univer. Press.

Ohliati, J., & Abbas, B. S. (2019). Measuring students satisfaction in using learning management system. *International Journal of Emerging Technologies in Learning, 14*, 180. https://doi.org/10.3991/ijet.v14i04.9427

Oyetade, K. E., Zuva, T., & Harmse, A. (2022). Factors influencing hackathon adoption for learning information technology (IT) programming modules. *TEM Journal, 11*, 1165-1171. https://doi.org/10.18421/TEM113-22

Oyetade, K. E., Zuva, T., & Harmse, A. (2023). Intention to use hackathon by information technology programming students. In M. R. Laouar, V. E. Balas, B. Lejdel, S. Eom, & M. A. Boudia (Eds.), *Proceedings of the 12th International Conference on Information Systems and Advanced Technologies* (pp. 80-92). Springer. https://doi.org/10.1007/978-3-031-25344-7_8

Ping, L., & Liu, K. (2020). Using the technology acceptance model to analyze K-12 students' behavioral intention to use augmented reality in learning. *Texas Education Review, 8*(2), 37-51.

Porras, J., Khakurel, J., Ikonen, J., Happonen, A., Knutas, A., Herala, A., & Drögehorn, O. (2018). Hackathons in software engineering education: Lessons learned from a decade of events. In *Proceedings of the 2nd International Workshop on Software Engineering Education for Millennials* (pp. 40-47). https://doi.org/10.1145/3194779.3194783

Porras, J., Knutas, A., Ikonen, J., Happonen, A., Khakurel, J., & Herala, A. (2019). Code camps and hackathons in education–Literature review and lessons learned. In *Proceedings of the 52nd Hawaii*

International Conference on System Sciences. https://doi.org/10.24251/HICSS.2019.933

Powell, J., Bailey Hayden, L., Cannon, A., Wilson, B., & Nolte, A. (2021). Organizing online hackathons for newcomers to a scientific community–Lessons learned from two events. In *Proceedings of the 6th Annual International Conference on Game Jams, Hackathons, and Game Creation Events* (pp. 78-82). https://doi.org/10.1145/3472688.3472700

Prifti, R. (2022). Self–efficacy and student satisfaction in the context of blended learning courses. *Open Learning: The Journal of Open, Distance and e-Learning, 37*, 111-125. https://doi.org/10.1080/02680513.2020.1755642

Ribault, S., Bessaguet, H., Ardaillon, H., Rousson, G., Nivesse, D., Fareh, T., Malishchuk, A. S., Milot, A., Eklu, B., Seguin, P., & Rode, G. (2022). To other new educational ways for interdisciplinary cooperation and innovation: About a student-driven hackathon. *Mededpublish, 20*. https://doi.org/10.12688/mep.18991.1

Rocha Estrada, F. J., Ruiz-Ramírez, J. A., George-Reyes, C. E., & Glasserman-Morales, L. D. (2022). Evaluation of a virtual campus adapted to web-based virtual reality spaces: Assessments of teachers and students. *Frontiers in Education, 7*. https://doi.org/10.3389/feduc.2022.918125

Steglich, C., Marczak, S., Guerra, L., Trindade, C., Dutra, A., & Bacelo, A. (2021). An online educational hackathon to foster professional skills and intense collaboration on software engineering students. In *Proceedings of the XXXV Brazilian Symposium on Software Engineering* (pp. 388-397). https://doi.org/10.1145/3474624.3476973

Steiger, J. H. (1990). Structural model evaluation and modification: An interval estimation approach. *Multivariate Behavioral Research, 25*, 173-180. https://doi.org/10.1207/s15327906mbr2502_4

Sun, P.-C., Tsai, R. J., Finger, G., Chen, Y.-Y., & Yeh, D. (2008). What drives a successful e-learning? An empirical investigation of the critical factors influencing learner satisfaction. *Computers & Education, 50*, 1183-1202. https://doi.org/10.1016/j.compedu.2006.11.007

Szymanska, I., Sesti, T., Motley, H., & Puia, G. (2020). The effects of hackathons on the entrepreneurial skillset and perceived self-efficacy as factors shaping entrepreneurial intentions. *Administrative Sciences, 10*. https://doi.org/10.3390/admsci10030073

Tawafak, R. M., Malik, S. I., & Alfarsi, G. (2020). Development of framework from adapted TAM with MOOC platform for continuity intention. *Development, 29*, 1681-1691.

Temiz, S. (2021). Open innovation via crowdsourcing: A digital only hackathon case study from Sweden. *Journal of Open Innovation: Technology, Market, and Complexity, 7*, 39. https://doi.org/10.3390/joitmc7010039

Teo, T. (2009). Modelling technology acceptance in education: A study of pre-service teachers. *Computers & Education, 52*, 302-312. https://doi.org/10.1016/j.compedu.2008.08.006

Terwiesch, C., & Xu, Y. (2008). Innovation contests, open innovation, and multiagent problem solving. *Management Science, 54*, 1529-1543. https://doi.org/10.1287/mnsc.1080.0884

Tucker, L. R., & Lewis, C. (1973). A reliability coefficient for maximum likelihood factor analysis. *Psychometrika, 38*, 1-10. https://doi.org/10.1007/BF02291170

Uys, W. F. (2020). Hackathons as a formal teaching approach in information systems capstone Courses. In B. Tait, J. Kroeze, & S. Gruner (Eds.), *ICT education* (pp. 79-95). Springer. https://doi.org/10.1007/978-3-030-35629-3_6

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four Longitudinal field studies. *Management Science, 46*, 186-204. https://doi.org/10.1287/mnsc.46.2.186.11926

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*, 425-478. https://doi.org/10.2307/30036540

Vermicelli, S., Cricelli, L., & Grimaldi, M. (2021). How can crowdsourcing help tackle the COVID-19 pandemic? An explorative overview of innovative collaborative practices. *R&D Management, 51*, 183-194. https://doi.org/10.1111/radm.12443

Wiggins, B. E. (2016). An overview and study on the use of games, simulations, and gamification in higher education. *International Journal of Game-Based Learning, 6*, 18-29. https://doi.org/10.4018/IJGBL.2016010102

William, S. B., Shu, N., Angela, L., James, K., Victor, P., William, P. F., Manuela, R. Z., Jye Quan, T., Abigail, S., Karisma, S., Ryan, K., Joshua, B., Stephen, J. C., Peter, R. C., & David George, J. (2021). Virtual hackathon to tackle COVID-19 unmet needs. *BMJ Innovations, 7*, 284. https://doi.org/10.1136/bmjinnov-2020-000456