Digitalizing skills development using simulation-based mobile (SiM) learning application

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Abstract In a volatile, uncertain, complex, and ambiguous (VUCA) world, education and training providers need to explore other pedagogical approaches in conducting technical and vocational courses. This study introduced a new approach to conducting electrical engineering related laboratory activities amidst online or hybrid learning modalities. Primarily, this paper examined the potential of using simulation-based (SiM) mobile learning application to develop technical and vocational skills of the users. The researcher-developed mobile learning application, Electrical Wiring Simulator (EWS), was used to collect the responses from the 345 users worldwide who downloaded the software from Google Play. The majority of the respondents came from the Republic of the Philippines, USA, Indonesia, India, Mexico, Myanmar, United Kingdom, Malaysia, and Portugal among others. The respondents reported a high potential to develop electrical wiring skills when using EWS. The results from Multiple Linear Regression Analysis indicated perceived usefulness (PU) and ease of using the mobile simulator significantly influenced the user’s potential electrical wiring skills development. Lastly, the PROCESS macro showed that there is not enough evidence to show that the generation of the learners significantly moderates the effect of perceived ease of use on potential skills development.

Keywords Electrical wiring simulator · Mobile learning · Skills development · TAM

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Introduction

Educators worldwide have hardships using and adapting to online or distance learning pedagogy (Isac & Peixoto, 2021; Joshi et al., 2020; Kashyap et al., 2021; Lagat, 2020). Conventionally, students learn theories through lectures and practical skills by performing laboratory activities. The safety constraints implemented during community quarantine protocols deprived students of using laboratory facilities and equipment physically. To address this issue, instructors were forced to use a recorded demonstration of laboratory activities or lab simulations (Allen & Barker, 2021). However, Dhawan believes that students’ learning process is incomplete because of the inability to apply what they learned (Dhawan, 2020).

Online virtual laboratories (VLab) or simulators allow the students to perform experiments in a simulated computer-based learning environment. It provides high-quality, flexible, damage-resistant, and more advanced virtual laboratory work (Potkonjak et al., 2016). Scholars believe that VLab enables students to have a one-on-one experience with expensive equipment (Ko et al., 2001) and increases learning (Koretsky et al., 2008; Wolf, 2009), achievement, and attitude (Tüysüz, 2010) towards the course. Most of these systems required personal computers and purchasing expensive software for each student, hence, implementing this advanced teaching technologies is impossible for small schools or students from low-income families.

The most common way of doing technical laboratory activities is through pre-recorded demonstration. Instructors download video resources online, while others are recording how to use a particular instrument, equipment, or facility. Students, on their end, can perform the activity if the materials are readily available. For activities requiring specialized training equipment such as electrical wiring and motor control trainers, electrohydraulic and electropneumatic trainers, learners just watch the video and create a narrative report afterward. However, this pedagogy defeats the purpose of conducting laboratory exercises. Chan argues that laboratory learning should develop students’ practical skills required to meet the course’s competencies (Ka Yuk Chan, 2012). Hence, a need to explore other pedagogical approach such as using mobile devices in conducting technical courses arises.

Mobile-based learning

In recent years, the COVID-19 pandemic reconfigured the way we learn things. Educational institutions were forced to migrate from the conventional face-to-face to online learning or eLearning. However, students prefer to use mobile devices because of their convenience, mobility, and affordability. Naciri et al. (2020) posit that mobile learning is an unavoidable alternative in Higher Education. Literature offers various definitions of mobile learning. M-Learning, as an extension of eLearning, is a pedagogical approach that does not need a fixed and
predetermined location (O’malley et al., 2003) and can be accessed anytime and anywhere (Almasri, 2014; Naciri et al., 2020; Vavoula & Sharples, 2002). This type of learning system uses digital devices that maximize portability (Traxler, 2005). Keegan (2005) simplifies learning platforms as devices that can be placed in a handbag or a pocket, excluding personal computers or laptops.

Mobile-based learning applications can be classified into four categories: organization, creation, social, and practice (Toledo, 2021). The most common organizational apps used in learning are Learning Management Systems or LMS. It enables the teachers to upload learning resources such as slideshow presentations, pre-recorded lectures, quizzes, assignments, and exams. Students can access the prepared course materials anytime and anywhere (Rabiman et al., 2020; Raza et al., 2021; Saroia & Gao, 2019). The study of Rabiman et al. (2020) shows that LMS increases student’s satisfaction and increases the quality of learning. The most popular mobile LMS used nowadays are Moodle, Blackboard, Schoology, Google Classroom, and Canvas by Instructure (Bouchrika, 2020; Sarrab et al., 2015). However, Juhaňák et al. (2019) argue that LMS applications do not have the inherent capability of knowing what is happening behind the screen. It fails to show the behavior and attitudes of students towards the learning materials.

The second category is creation applications. These applications are used to create something from scratch or a template (Toledo, 2021). They can be used for note-taking, modeling, or report presentation. According to Turner (2021), the best note-taking mobile applications as of June 2021 are Microsoft 365, Evernote, Ulysses, Simplenote, Bear, Dropbox Paper, Google Keep, and Atom. Scholars believed that note-taking using mobile devices is beneficial for learners (Foti & Mendez, 2014; Popescu et al., 2016; Schepman et al., 2012). For modeling, the most commonly available in Google Play are Sketchbook, AutoDesk, Draw.io, and Lucidchart (Toledo, 2021). Google Slides, Canva, Ludus, Beautiful.ai, Prezi, Powtoon, Genially, Powerpoint are the best presentation software for 2021 (Abbamonte, 2021).

The third category is social applications. Toledo (2021) defines these mobile apps as tools used for communication, such as messaging and audio or video conferencing. Announcements, instructions, and any form of messages are normally relayed using emails, Facebook messenger, SMS, or integrated into the LMS. Drake and Turner (2021) reported that the best video conferencing software in 2021 are GoToMeeting, RingCentral Video, Microsoft Teams, Google Meet, Zoom Meetings, ClickMeeting, U Meeting, BigBlueButton, Bluejeans Meetings, and Lifesize. Literature showed that video conferencing enhances students’ learning (Lenkaitis, 2020; Mpungose, 2021), competency, and performance (Al-Samarraie, 2019). Also, studies on medical students showed that their acquired knowledge does not significantly differ from in-person lectures (Brockfeld et al., 2018; Solomon et al., 2004; Vaccani et al., 2016). However, Mpungose (2021) stresses that video conferencing digital fatigue, autonomy, and emotional connectedness should be addressed.

Lastly, the fourth category is practice applications. Toledo (2021) states that it can be further classified as Student Response System (SRS) or Learning Games applications. SRS enables teachers to ask commonly multiple-choice questions and
receive answers in real-time (Tomaswick, 2016). Emmen (2015) reported that the top 5 commonly used SRS are Kahoot, Socrative, Infuse Learning, Quiz Socket, and Verso. Learning games, on the other hand, are more student-centered (Toledo, 2021). Students will play the game for a specific purpose anchored on the learning objectives set by the instructors. However, Whitton (2007, 2010) argues that design characteristics or features of an application should be examined to differentiate mobile game-based from game-like systems.

Extended technology acceptance model (TAM)

Almaiah et al. (2016) examined the effects of quality features based on the updated DL&ML model (Delone & McLean, 2003) as the antecedents on mobile learning acceptance. The nine application features are learning content quality, content design quality, interactivity, functionality, user-inter design, accessibility, availability, personalization, and responsiveness. These factors were regressed to test their influence on perceived usefulness (PU) and ease of use (PEOU). Then, the effect of PU and PEOU on the behavior intention to use was tested. The results of their study stated that availability ($\beta = 0.064, p = 0.005$) is not a statistically significant factor predicting perceived usefulness (PU). However, they failed to explain using a statistical significance level at 0.001. Nonetheless, identifying the significant factors affecting usefulness and ease of use overcome the shortcomings of TAM.

Scholars believed that perceived usefulness is influenced by good content quality resources (Lee, 2006), interactivity (Pituch & Lee, 2006), functionality (Albelali & Alaulamie, 2019; Cho et al., 2009), user interface design (Cheng, 2012; Eraslan Yalcin & Kutlu, 2019), and responsiveness (Cheng, 2012; Sarrab et al., 2016) of a mobile learning application. Interactivity is the reciprocal action or influence between students and teachers and among students themselves (Almaiah et al., 2016; Cheng, 2012; Pituch & Lee, 2006). Several studies defined functionality as a function of a learning platform that enables users to have flexible access on the instructional materials (Almaiah et al., 2016; Cheng, 2012; Cho et al., 2009; Pituch & Lee, 2006). Cho et al. (2009) define user interface design as the information systems’ structural design, including its features and instructional support (Almaiah et al., 2016; Cheng, 2012). It is related to how the menu bars, control bars, aspect ratio, screen design, icons are arranged in a system (Eraslan Yalcin & Kutlu, 2019). Pituch and Lee (2006) define responsiveness as how fast, reasonable, and consistent a user receives a response from the system.

Several studies explained that learning systems with good figures, clear text (Leflore, 2000), accurate and consistent contents (Lee et al., 2009) will lead to ease of use. Almaiah et al. (2016) reported that the higher the accessibility level of a learning platform, the higher the PEOU. Al-Debei (2014) defines accessibility as the ease of access and extract information from a system. Scholars have shown that
persons with disabilities are the most affected in terms of accessibility of learning platforms (Alsobhi & Abeysinghe, 2013; Cooper et al., 2016; Zeithaml et al., 2002). However, the practical application of TAM is limited from the perspective of technology developers. Although, it is more important to identify what makes an application useful and easy to use, Bagozzi (2007) argued that the behavior intention to use technology should be considered as an antecedent to a bigger goal. The arguments of Almaiah et al., (2016), Bagozzi (2007), Davis (1989), Delone and McLean (2003) were carefully considered in the integration of potential technical and vocational skills development as the end goal of using mobile applications used for learning.

**Technical and vocational skills development (TVSD)**

Several studies showed that e-Learning (Jayalath & Esichaikul, 2022; Madimabe & Omodan, 2021; Munyi et al., 2021; Obi et al., 2020; Pangeni & Karki, 2021; Samah & Ismail, 2021), mobile Learning (m-Learning) (Kiarie, 2016; Rusli et al., 2019; Wilke, 2017), and augmented reality technology (Farias et al., 2019; Halim et al., 2020; Rusli et al., 2019) can be integrated to have a more efficient delivery of TVET. However, most of the available e-Learning and m-Learning applications are used for organization such as LMS. Some of the mobile applications only displays texts and videos on how to do things. However, Ahmad et al. (2019) stresses the importance to integrate psychomotor factors in the LMS used for TVET. Although augmented virtual reality might address this issue, most of the students in the rural areas do not own personal computers or laptop.

TVET, as defined by UNESCO (2015), “is understood as comprising education, training and skills development relating to a wide range of occupational fields, production, services and livelihoods.” Wahba (2013) elaborates that TVET has a social objective to prepare the learners from secondary education to work and economic objective by providing the labor market with competent workers. However, during the pandemic learners were not able to physically perform practical exercises posing for potential skills gap or degradation. Hence, a future proof skills development pedagogy is needed.

To cope with the above-mentioned issues, this study examined the potential of using simulation-based mobile learning (SiM-Learning) applications, such as Electrical Wiring Simulator, to develop the electrical wiring skills of students amidst distance or online learning. Specifically, this paper answered the following research questions:

- **RQ1** What is the level of perceived usefulness (PU) and ease of using (PEOU) Electrical Wiring Simulator?
- **RQ2** What is the level of students’ potential electrical wiring skills development when using Electrical Wiring Simulator?
- **RQ3** Does the perceived usefulness of Electrical Wiring Simulator significantly influence students’ potential electrical wiring skills development?
- **RQ4** Does the perceived ease of using Electrical Wiring Simulator significantly influence students’ potential electrical wiring skills development?
- **RQ5** Does the generation of users significantly moderate the effect of perceived ease of use towards potential electrical wiring skills development?

**Conceptual framework**

The conceptual framework of this study is adapted from the Mobile Learning Acceptance Model of Almaiah et al. (2016). However, this paper proposes three primary main developments. First, instead of exploring mobile learning (M-Learning) applications, the researcher narrowed the study to simulation-based mobile learning (SiM-Learning) applications, as shown in Fig. 1. Secondly, instead of using behavior intention to use an application as an end goal (Bagozzi, 2007), the researcher examined the effect of PU and PEOU on the potential technical and vocational skills development of users. Lastly, this paper investigated the moderating effect of the users’ generation on their potential electrical wiring skills development.

**Research hypotheses**

The research questions of the study were both descriptive and inferential in form. Descriptive questions simply describe the statistic of the dependent and independent variables while inferential questions were used to draw conclusions of the

![Proposed conceptual model](image-url)
population’s parameter from the sample’s statistics (Berenson et al., 2012; Creswell, 2009). Since descriptive questions do not require a hypothesis, hence, the corresponding null hypotheses for the research questions 3–5 are as follows:

- $h_{01}$ Perceived usefulness of Electrical Wiring Simulator does not significantly influence students’ potential electrical wiring skills development.
- $h_{02}$ Perceived ease of using Electrical Wiring Simulator does not significantly influence students’ potential electrical wiring skills development.
- $h_{03}$ Generation of the users does not significantly moderate the effect of perceived ease of use towards potential electrical wiring skills development.

**Research methodology**

This study used quantitative approach—postpositivist worldview, non-experimental survey strategy of inquiry using an observational approach with an explanatory design.

**Data gathering instrument**

The researcher adapted the items to measure the constructs from Almaiah et al. (2016). As stated in their paper, the measurement items were modified from the studies of various scholars. The indicators for perceived usefulness and perceived ease of use were adapted from from Mohammadi (2015) and behavioral intention to use from Hassanzadeh et al. (2012). The indicators of the potential electrical wiring skills development were developed by the researcher.

The questionnaire was pretested with 30 users to measure the reliability of the constructs. A reliability test is the ability of a measure to produce the same result under the same conditions (Field, 2009). This paper followed the generally accepted interpretation of $\alpha$ for interval-scaled questions. Values greater or equal to 0.7 are considered acceptable, while values greater or equal to 0.9 are considered excellent. The testing showed that all alpha values are greater than 0.9, hence, the items to measure the constructs have excellent internal consistency. The indicators, sources and the Cronbach’s alpha for each construct is attached in Appendix.

**Sampling technique**

The survey was distributed to all users worldwide. As of July 20, 2021, the researcher-developed android-based simulator had 6090 downloads. The sample size computation was performed using the Raosoft online sample size calculator. Given a margin of error of 5%, confidence level of 95%, population size = 6090, and 50% response distribution, the recommended sample size is 362 observations. However, the researcher only gathered 345 valid responses from September 7, 2021 to March 20, 2022.
Procedure of the study

During the dissertation period, the researcher designed and developed a simulator-based mobile learning (SiM-Learning) application called Electrical Wiring Simulator (EWS). The android simulator was developed using Unity a free game development software by Unity Technologies. EWS was published in Google Play on April 19, 2021.

EWS attempts to promote electrical wire skills development of students, especially in electrical, electronics, and marine engineering. The app includes basic wiring scenarios for electrical, electronics, and control engineering systems. The main menu of the simulator is shown in Fig. 2. By clicking one of the icons, the display will be redirected to the activities inside that module.

The wiring scene of the platform is shown in Fig. 3. The user needs to connect the terminals of the components based on the given schematic diagram. EWS allows wire deletion using the plier icon. Undo button and reset all wiring are available for convenience.

After wiring the circuit, the user has to click the submit button to check if the wiring is correct. If all the wires are successfully connected, the user can press the input button to simulate the system’s functionality. For instance, in Fig. 4, if the user presses the pushbutton PB2, the pilot lamp PL3 turns on and remains in the state. If the user presses PB1, then it will turn off while turning on pilot lamp 2.

The informed consent and the survey questionnaire were embedded on the Electrical Wiring Simulator. In order to qualify as respondents of the study, users had to complete at least five activities before the “Take Survey” button will be enabled. This ensured that users have enough experience of using the simulator and can assess the perceived usefulness, ease of use and potential electrical wiring skills development of the mobile learning application. After the user agreed to the participate in the study, the respondents were redirected to the main survey page. Both

![Fig. 2 EWS main menu](image-url)
the responses of the informed consent and the survey were submitted from EWS to the Google Sheet through Google Form. This application-embedded method is an extension to the conventional data collection using Google forms amidst the restrictions of conducting quantitative research during the pandemic (Torrentira, 2020).

The respondents of the study includes students and lifelong learners from Generation Z (1997–2012) to Baby Boomers (1946–1964). The EWS can be used by the Gen Z and Millennial (1981–1996) students taking electrical related tracks and courses such as Electrical Installation and Maintenance, Electrical Engineering,
Electronics Engineering or Marine Engineering. Also, Gen X (1965–1980) and Baby Boomers (1946–1964) may use the developed mobile learning application for instruction purposes, research, skills development or as a lifelong learning activity.

**Statistical treatment**

Frequency distribution, arithmetic mean, multiple regression analysis, and PRO-CESS macro by Hayes were used to answer the research questions of the study. Frequency distribution was used to display the demographic profile of the respondents. This includes the presentation of their generation, highest educational attainment, and the country of origin. Arithmetic mean was used to answer the research questions related to the level of perceived usefulness, level of perceived ease of use (RQ1) and level of potential electrical wiring skills development (RQ2). Table 1 was used to interpret the means for each variable.

Multiple Linear Regression Analysis was used to explain the influence of PU and PEOU on potential electrical wiring skills development. Testing the assumptions for Multiple Regression Analysis was performed prior to the interpretation of the regression coefficients. Hair et al., (2014, p. 178) discussed that the assumptions to be examined are the linearity of the phenomenon to be measured, constant variance and independence of the error terms, and the normality of error term distribution. In addition, they argued that multicollinearity among the independent variables had to be assessed (Hair et al., 2014, p. 196). In addition, PROCESS Macro by Hayes (2022) was used to test if the respondents’ generation significantly moderates PEOU towards potential skills development.

**Results and discussion**

**Demographic profile**

The distribution of the respondents based their generations, highest educational attainment, and the country of origin were presented in the succeeding tables. Table 2 showed that most of the respondents were millennials ages 23–38 years old. Also, the table indicates that 90.1% of the respondents belongs to the Gen Z and Millennials. This implies that the younger generations are more eager to explore new ways of learning, acquiring or reinforcing their electrical wiring skills.

The highest educational attainment of respondents were bachelor’s degree and senior high school as shown in Table 3. The table indicated that they comprised the

| Table 1 Interpretation of means | Range interval | Interpretation |
|--------------------------------|----------------|---------------|
|                                | 4.21–5.00      | Very high     |
|                                | 3.41–4.20      | High          |
|                                | 2.61–3.40      | Moderate      |
|                                | 1.81–2.60      | Low           |
|                                | 1.00–1.80      | Very low      |
84.3% of the total number of respondents. This implied that the online or distance learning modality forced the students and teachers to try new pedagogy on learning practical skills.

The distribution of the respondents based on their country of origin is shown in Table 4. The data showed that 51.31% of the responses came from the Republic of Philippines and the USA. Other countries not presented in the table were from Germany, Egypt, Belgium, Canada, Lithuania, Thailand, Argentina, Bulgaria, Fiji, Iraq, Ireland, Italy, Lebanon, Morocco, Netherlands, New Zealand, and Sudan.

### Level of perceived usefulness (PU)

The level of usefulness as perceived by the respondents is shown in Table 5. The statistics showed that all the indicators have high mean level and standard deviation (SD) at almost 1.0. High SD values imply high variability in the dataset. In this case, the score of each indicator may vary one unit below and above the mean. Hence, the interpretation may vary from moderate to very high level.

The statistics showed that EWS was perceived useful by the respondents as it increases the effectiveness, productivity and engagement in the learning environment. Considering online classes amidst the pandemic, it allows the teachers and learners to engage in a new pedagogy of doing electrical wiring activities. However, it can be observed that the indicator with the lowest score is the ability to accomplish the actual task with real equipment more quickly.

Also, the relationship between perceived usefulness and generations of the respondents were examined as shown in Table 6. Spearman’s rho correlation coefficient showed that there is a significant negative relationship between generation

| Table 2 | Distribution of respondents based on generations |
|---------|-----------------------------------------------|
| Generation | Age range | Frequency | Percentage |
| Gen Z (1997–2012) | 7–22 years old | 125 | 36.2 |
| Millennials (1981–1996) | 23–38 years old | 186 | 53.9 |
| Gen X (1965–1980) | 39–54 years old | 31 | 9.0 |
| Baby Boomers (1946–1964) | 55–73 years old | 3 | 0.9 |
| Total | 7–73 years old | 345 | 100.0 |

| Table 3 | Distribution of respondents based on educational attainment |
|---------|-----------------------------------------------------|
| Educational level | Frequency | Percentage |
| Doctoral or higher | 1 | 0.3 |
| Master’s degree | 11 | 3.2 |
| Bachelor’s degree | 145 | 42.0 |
| Senior high school | 146 | 42.3 |
| Junior high school | 22 | 6.4 |
| Elementary | 9 | 2.6 |
| Prefer not to say | 11 | 3.2 |
| Total | 345 | 100.0 |
of the respondents and the level of perceived usefulness, $r_s = -0.131$, $p = 0.015$, $N = 345$. This signified that as the age of users increases, the perceived level of usefulness decreases, and vice versa.

**Level of perceived ease of use (PEOU)**

The perceived level of ease of using Electrical Wiring Simulator was displayed as in Table 7. On average, the mean values exhibited high level of user-friendliness, easy to use for learning using mobile devices and does not require too much effort to use.
However, the ease of using the mobile simulator showed a decreasing level from Gen Z to Gen X. Although there is an increase level for Baby Boomers \( (M=4.10, SD=1.0) \), the variability is also the highest. Spearman’s rho correlation coefficient showed that there is a significant negative relationship between generation of the respondents and the level of perceived ease of use, \( r_s = -0.131, p=0.015, N=345 \). This indicated that, on average, as the age of the users increases the perceived ease of use decreases, and vice versa.

**Level of potential electrical wiring skills development**

The level of perceived potential electrical wiring skills development is shown in Table 8. On average, all the mean scores displayed very high levels. This implied that users believed that using EWS will help them improve their electrical wiring skills such as reading and understanding basic schematic diagrams, and doing the actual similar wiring with real electrical components.

The mean of potential skills development of users based on their generation is shown in Table 9. The relationship of the respondents’ generation and potential skills development was tested using Spearman’s rho correlation. The coefficient showed that there is a significant negative relationship between the two variables, \( r_s = -0.182, p=0.001, N=345 \). This indicated that, on average, as the age of the users increases the perceived potential electrical wiring skills development decreases, and vice versa.

**Influence of PU and PEOU on potential skills development**

The partial regression plots between the potential electrical wiring skills development and independent variables showed that there were no major violations on the assumption of linearity and independence on error terms. In addition, Fig. 5 displays similar pattern to a null plot, hence, satisfying the assumption on homogeneity of error terms. The standardized plot in Fig. 6 shows that the data points were closer to the line, hence, no major problem on the normality assumption. Lastly, the values of variance inflation factor were less than five, hence, the assumption on multicollinearity was met.

As shown in Table 10, the results from the Multiple Linear Regression using Enter method indicated that the changes in the level of perceived potential electrical wiring skills development can be explained by the changes on the level of

### Table 7 Mean of perceived ease of use (PEOU)

| Indicators                                      | Mean | Standard deviation | Interpretation |
|------------------------------------------------|------|--------------------|----------------|
| The EWS is easy to use                         | 4.16 | .94                | High           |
| Your interaction with the EWS is clear and understandable | 4.17 | .91                | High           |
| I find EWS easy to use for learning           | 4.19 | .88                | High           |
| Using EWS does not require much effort for me | 4.15 | .89                | High           |
| Overall, EWS is user-friendly                 | 4.25 | .84                | High           |
| Overall                                        | 4.18 | .78                | High           |
perceived usefulness and ease of use \((F(2, 342) = 630.152, p < .001, R^2 = .787, R^2_{\text{Adjusted}} = .785)\). The analysis showed that both PU \((t(344) = 11.674, p < 0.001)\) and PEOU \((t(344) = 8.543, p < 0.001)\) can significantly influence the potential electrical wiring skills of users as shown in Table 11.

**Interaction of users’ generation on the effect of PEOU to PSD**

A moderating analysis was also performed to probe the interacting effect of user’s generation and perceived ease of use to the level of potential electrical wiring skills development. The p-value in Table 12 indicated that the overall model is significant, however, the test of interactions showed that there is no statistically significant interaction between perceived level of ease of use and the generations of the respondents \((F(3,328) = 0.486, p = 0.692)\) as shown in Table 13. This implied that the SIM-Learning applications users’ age or generation does not moderate the effect of the level of ease of use on the perceived potential skills development. The summary of hypotheses testing is shown in Table 14.

**Conclusions and future works**

The findings showed that level of perceive usefulness and ease of using the Electrical Wiring Simulator were both high. The test of correlation between usefulness and the users generation indicated a significant negative relationship. This

| Table 8  | Mean of potential skills development (PSD) |
|----------|-------------------------------------------|
| Indicators                                                                 | Mean | Standard deviation | Interpretation |
| I believe that using EWS, I develop my skills in reading basic schematic diagram | 4.28 | .83 | Very high |
| I believe that using EWS, I can understand basic schematic diagram            | 4.33 | .80 | Very high |
| I believe that using EWS, I can wire basic circuit following a diagram         | 4.31 | .82 | Very high |
| I believe that using EWS, I can wire similar circuits with actual components   | 4.29 | .83 | Very high |
| Overall, I believe that EWS will help me improve my electrical wiring skills  | 4.38 | .76 | Very high |
| Overall                                                                      | 4.32 | .73 | Very high |

| Table 9  | Mean PSD based on respondents’ generations |
|----------|--------------------------------------------|
| Generations                                                                 | Count | Mean  | Standard deviation |
| Generation Z (1997–2012)                                                    | 125   | 4.50  | 0.70               |
| Millennials (1981–1996)                                                     | 186   | 4.20  | 0.70               |
| Generation X (1965–1980)                                                    | 31    | 4.10  | 0.80               |
| Baby Boomers (1946–1964)                                                   | 3     | 4.00  | 1.00               |
implied that as the age of users increases, the usefulness of EWS decreases, and vice versa. The relationship of perceived ease of use and generation showed similar relationship. As the age of users increases, the ease of using EWS decreases. Hence, the users from the older generation may found using simulation-based mobile (SiM) learning applications less useful and easy to use.

The results indicated that the potential for technical skills development when using a simulation-based mobile (SiM) learning application is very high. Hence, students may consider using the Electrical Wiring Simulator (EWS) to improve their electrical wiring skills amidst the limitation of performing laboratory activities within school or training vicinities. EWS reinforces the skills of students or trainees since they can review and practice electrical wiring activities anytime and anywhere. This pedagogical approach reduces the skills degradation of learners.

The regression analysis showed that the perceived usefulness (PU) and ease of use (PEOU) significantly influenced the potential skills development (PSD) of users. Hence, the developers of Electrical Wiring Simulator should consider improving the quality features such as modular exercises, features and the wiring interface. This will increase the potential of the application to improve and reinforce the electrical skills of the users.

The test of moderation showed that the generation of the users does not significantly moderate the effect of perceived ease of use on the potential of a SiM learning application to develop the skills of the users. Although the generation or age of users and PEOU have a negative relationship, the test of interaction indicated that
Fig. 6  Potential skill development Q–Q plot

Table 10  Model summary on PSD

| Model | $R$  | $R^2$ | Adjusted $R^2$ | Std. error of the estimate | Durbin–Watson |
|-------|------|-------|----------------|---------------------------|---------------|
| 1     | .887$^a$ | .787  | .785          | .3364                    | 1.959         |

Dependent variable: potential electrical wiring skills development

$^a$Predictors: (constant), perceived ease of use, perceived usefulness

Table 11  Influence of PU and PEOU on PSD

| Model                  | Unstandardized coefficients | $t$   | Sig. |
|------------------------|-------------------------------|-------|------|
| (Constant)             |                               |       |      |
|                       | $B$                           | $t$   | $p$  |
| Perceived usefulness   | .505                          | 11.674| .000 |
| Perceived ease of use  | .362                          | 8.543 | .000 |

Table 12  Model summary

| $R$  | $R^2$ | MSE   | $F$   | $df_1$ | $df_2$ | $p$   |
|------|-------|-------|-------|--------|--------|-------|
| 0.889| 0.791 | 0.113 | 158.898| 8      | 336    | 0.000 |
user’s generation does not strengthen or weaken the effect of PEOU on the potential wiring skills development of users.

Relative to the findings of this paper, the Department of Education (DepEd), Higher Education Institutions (HEIs), Commission on Higher Education (CHED), Maritime Industry Authority (MARINA), and Technical Education and Skills Development Authority (TESDA) may consider accreditation, certification or partnership to the developers of Simulation-based Mobile (SiM) learning applications to strengthen the digital transformation of conducting technical laboratory or training exercises. This will ensure the quality and alignment of the developed applications to meet the required competencies of the course.

For future research, other SiM-Mobile learning applications can be developed for potential skills development in other engineering or non-engineering-related courses. With the physical restrictions related to the pandemic being lifted, researchers may consider improving the study’s dependent variable by changing potential skills development to the actual or practical technical and vocational skills development.

Declarations

Conflict of interest There was no potential conflict of interest reported by the author.

Ethical approval All the procedures conducted in the study were in accordance with the institution’s ethical standards.

Informed consent Informed consents were obtained from the respondents and the data were treated with utmost confidentiality.
Appendix

See Table 15.

### Table 15 Constructs, indicators, sources and Cronbach’s alpha

| Construct                        | Measure                                                                 | Sources                                                                 | $\alpha$ |
|----------------------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------|----------|
| Perceived usefulness             | Using EWS would enable me to accomplish tasks more quickly             | Almaiah et al. (2016), Mohammadi (2015)                                  | 0.954    |
|                                  | Using EWS would improve my performance in learning environment         |                                                                         |          |
|                                  | Using EWS would increase my productivity in learning environment        |                                                                         |          |
|                                  | Using EWS would enhance my effectiveness in learning environment        |                                                                         |          |
|                                  | Using EWS would make it easier for me to engage in learning environment |                                                                         |          |
| Perceived ease of use            | The EWS is easy to use                                                 | Almaiah et al. (2016), Mohammadi (2015), Zhonggen and Xiaozhi (2019), Chavoshi and Hamidi (2019) | 0.942    |
|                                  | Your interaction with the EWS is clear and understandable               |                                                                         |          |
|                                  | I find EWS easy to use for learning                                    |                                                                         |          |
|                                  | Using EWS does not require much effort for me                          |                                                                         |          |
|                                  | Overall, EWS is user-friendly                                         |                                                                         |          |
| Potential electrical skills      | I believe that using EWS, I develop my skills in reading basic schematic diagram | Researcher-developed                                                    | 0.957    |
| development                      | I believe that using EWS, I can understand basic schematic diagram      |                                                                         |          |
|                                  | I believe that using EWS, I can wire basic circuit following a diagram  |                                                                         |          |
|                                  | I believe that using EWS, I can wire similar circuits with actual components |                                                                     |          |
|                                  | Overall, I believe that EWS will help me improve my electrical wiring skills |                                                                    |          |
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