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The Relationship Between Students' Digital Competency Skills and Adaptation to Industry 4.0 Learning Technologies

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Abstract

This study delves into a novel and crucial area of research, exploring the impact of digital competency skills on Universiti Teknologi Malaysia (UTM) students' adaptation to the Fourth Industrial Revolution (IR 4.0) learning technologies. IR 4.0 is characterized by rapid technological developments that require individual adaptability and flexibility skills. Industry 4.0 (IR 4.0) learning technology uses advanced technologies such as artificial intelligence, machine learning, robotics and the Internet of Things (IoT) in education. As such, students must acquire these skills to prepare for the future workforce. Hence, this study was conducted to measure the impact of students' digital competency skills on adapting to IR 4.0 learning technology. Data was collected from undergraduate students in the Management, Science, and Computing faculties using a quantitative approach—the research employed methods of descriptive analysis, correlation and multiple regression. Findings indicate varying levels of influence among digital competency skills, with safety and problem-solving skills exhibiting the highest impact. A significant positive correlation is established between these skills and students' adaptation to IR 4.0 technologies. Information and data literacy emerges as the most influential skill. Multiple regression analysis underscores the significance of information and data literacy in predicting students' adaptation. The study contributes valuable insights for institutions aiming to enhance students' readiness for the evolving landscape of IR 4.0 learning technologies.

Keywords: Digital Competencies Skills, IR 4.0 Learning Technologies, Digcomp Framework 2.2, Adaptation

Introduction

In the ever-changing landscape of technology, the Fourth Industrial Revolution (IR 4.0) has emerged as a transformative force, reshaping how individuals engage with the world. This study focused on Universiti Teknologi Malaysia (UTM) and recognized the pivotal role of UTM students in this digital transformation. It seeks to unravel the intricate relationship between UTM students' digital competency skills and their adaptation to IR 4.0 learning technologies. Education is at the forefront of this revolution as the world rapidly transitions into a technology-driven era. IR 4.0 learning technologies, encompassing extensive data mining, artificial intelligence and the Internet of Things, fundamentally alter the educational landscape. It is crucial to understand how students, particularly at UTM, navigate this digital terrain and adapt to the demands of the Fourth Industrial Revolution. The challenges faced by students in this digital transformation are multifaceted. Insufficient knowledge about IR 4.0 and inadequate digital skills hinders students' adaptation. The disruptive impact of the COVID-19 pandemic has further accelerated the need for hybrid education, challenging students and educators alike to navigate online and remote learning environments effectively. In response to these challenges, this study aims to identify the gaps in understanding how UTM students develop and apply digital competency skills in adapting to the evolving digital environment (Vishnu et al., 2022).

Understanding how students, especially UTM students, navigate this digital landscape and adapt to the demands of the Fourth Industrial Revolution is critical. The challenges students face in digital transformation are varied. Inadequate IR 4.0 knowledge and insufficient digital skills hinder students' adaptation. The disruptive impact of the COVID-19 pandemic has further accelerated the need for blended teaching, challenging students and educators to navigate online and remote learning environments effectively. To address these challenges, this study aims to identify gaps in understanding how UTM students develop and apply digital skills to adapt to the changing digital environment (Vishnu et al., 2022). This study's main objective is to explore digital skills' impact on UTM students' adaptation to IR 4.0 learning technologies. By understanding the complex relationship between digital literacy and student adaptability, the study aims to provide valuable insights into factors that contribute to successful adaptation in the digital domain (Fraile et al., 2018). This study focuses on UTM, specifically targeting undergraduate students from three faculties: Management, Natural Sciences, and Computer Sciences. The study, which began in March 2023, used a survey-based data collection method to understand the impact of digital skills on students' adaptation to IR 4.0 learning technologies (Zulkarnain et al., 2021).

The significance of this study extends beyond the scope of UTM. The findings have practical implications for educational institutions, future researchers, and society. By addressing digital literacy challenges, institutions can improve student outcomes and effectively integrate technological advancements into their educational practices. Additionally, this study contributes to a broader understanding of digital literacy and IR 4.0 technologies and may inspire further research in this evolving field (Reddy et al., 2020). Insights gained from this study can inform curriculum development, teaching strategies, and policymaking to ensure that students are well-prepared to succeed in the digital age. Therefore, this study primarily aims to analyze the impact of UTM students' digital skills on adapting to IR 4.0 learning technologies. This study also explores the factors influencing university students' digital skills adaptation and the relationship between digital skills and IR 4.0 learning technology

adaptation. By shedding light on these critical aspects, the study aims to help education stakeholders foster a more digitally literate and adaptable student body, ultimately contributing to the success of the Fourth Industrial Revolution. r

Literature Review

The Technology Acceptance Model (TAM) by Davis (1989) is the research model applied in this study because it provides a framework for analysing and predicting people's acceptance and adoption of emerging technologies. The adaptation of IR 4.0 learning technologies among UTM students is a multifaceted exploration encompassing various dimensions. In defining the concept, IR 4.0, often called the Fourth Industrial Revolution, represents a combination of automation, machine learning and real-time data, highlighting its transformative impact on lifestyles, business operations and economic expansion (Zulkarnain et al., 2021). Industry 4.0 integrates physical, digital, and biological systems, giving rise to "smart" technologies and interconnected networks that profoundly influence diverse sectors such as manufacturing, healthcare, and transportation. This era fosters the digitisation and automation of activities, presenting opportunities for innovation and economic development. The application of sophisticated technologies, including artificial intelligence, the Internet of Things and automation, characterises IR 4.0, guiding a new era with far-reaching implications for daily life and societal structures.

Within the field of education, IR 4.0 learning technologies indicate advanced digital platforms aligned with the essence of the Fourth Industrial Revolution. The paradigm shifts in education are driven by dynamic tools such as mobile learning apps, virtual reality applications and adaptive educational systems (Qureshi et al., 2021). The approach of IR 4.0 learning technologies points to a departure from traditional educational models, necessitating institutions to adapt and embrace digital transformations. Zahra et al (2022) argue that game-based learning and digital tools enhance engagement, participation and learning outcomes among students, making these technologies crucial in shaping the future of education. Recognising the importance of preparing students for workforce demands, fostering future-ready skills and enhancing digital literacy, IR 4.0 learning technologies emerge as a dynamic catalyst. They equip students with essential skills, ensuring their adaptability in a digitally evolving landscape while addressing challenges and seizing opportunities posed by the digital era.

Based on the Dig Comp Framework 2.2 studied in this research, digital content creation has also been introduced. It enables individuals to participate in the digital environment actively, express their views safely, and connect across various digital mediums and media. The ability to generate and modify digital content across multiple formats, such as presentations with multimedia, films, and written works, is a crucial skill that allows individuals to convey themselves creatively and effectively in digital media. Digital content creation is a critical competency that helps individuals to produce and edit digital content in various forms (Meneses et al., 2020). According to Zulkarnain et al (2021), digital content creation, by definition, involves developing and editing new content (from word processing to photos and video), integrating and re-elaborating prior information and content, and producing creative expressions, media outputs, and programming to manage and implement intellectual property rights and licencing.

The fourth component of DigComp framework 2.2, which is safety in general, encompasses the abilities necessary to protect things like electronic gadgets, personal data, people's health and the environment. Students must depend on digital technologies and appropriate data and information management to participate in digital learning (Scheel et al., 2022). In this context, we are talking about safety in terms of how students can safely utilise the digital learning environment without becoming victims of cyberbullying. As we know, as the world evolves towards the era of digital technology, it comes with a few consequences. Cyberbullying, identity theft, phishing, and online scams are among the many issues and threats studied by researchers who examined the digital environment. An article by Dodel and Mesch (2019) argues that cybersecurity is the main reason for cyberbullying and breach of confidentiality among students due to the lack of knowledge of the digital world.

According to an article on challenges by students reporting online digital insecurity, it is mentioned that developing digital competency abilities, combined with a heavy emphasis on safety, provides students with the tools and information they need to manage all aspects of the ever-changing digital environment. Students can make intelligent judgments, secure their online identities and participate appropriately in online environments if they are aware of potential risks associated with sophisticated technologies. This complete understanding equips students to take advantage of the benefits of today's technology while avoiding threats, resulting in a more secure and efficient digital experience (Ong, 2021). Additionally, the literature examines the psychological and emotional well-being components of digital safety with a particular focus on concerns regarding issues like digital dependency, online harassment and even screen time management.

Lastly, the problem-solving component in DigComp Framework 2.2 emphasizes the importance of individuals developing competency in detecting problems, assessing information, analysing potential solutions and applying effective digital problem-solving procedures. Fundamentally, individuals are capable of resolving conceptual and technical problems while continually improving both their own and other's digital competencies if they possess the skill to identify digital resources and requirements, make educated choices regarding the most acceptable digital tools for particular tasks and utilize technologies creatively (Zulkarnain et al., 2021). According to Van Laar et al (2020), an essential aspect of problem-solving digital abilities is the capacity to apply information and communication technologies (ICTs) to analyse an issue and then apply this knowledge to create a solution. Problem-solving requires accumulating new information and its implementation in circumstances that must be investigated to discover and implement a solution. Because of this, having the ability to construct meaningful issue representations by integrating the knowledge in a particular setting is of crucial relevance.

A Proposed Conceptual Model/Framework

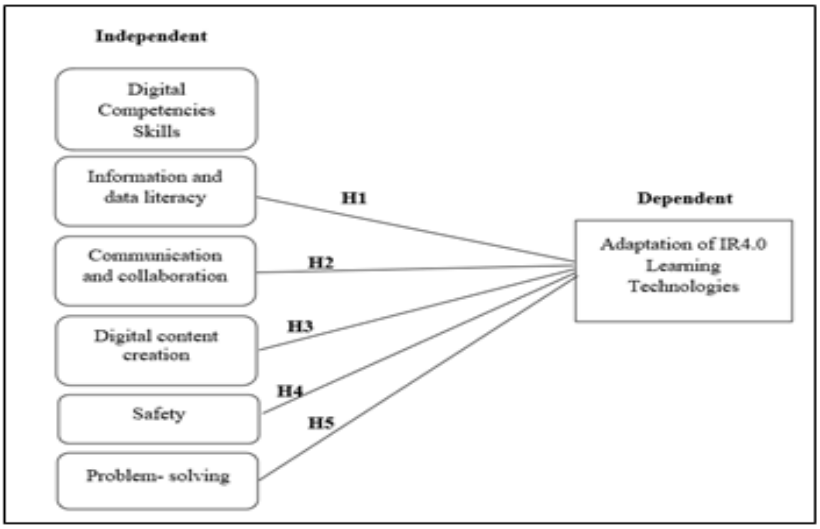

Figure 1. The Proposed Conceptual Model/Framework

The research framework can be viewed as a model that has been developed from a theoretical framework depending on the purpose of the research. According to the research objective, the first variable will be digital competencies skills among UTM students. Meanwhile, the second variable is the adaptation of IR 4.0 learning technologies among UTM students. According to the latest research, continual progress and technological expansion make room for the digital evolution of education and consequently influence students to adapt to the IR 4.0 learning technologies (Qureshi et al., 2021).

Research Methodology

The target population is the people the researcher has set out to gather information from to fulfil the study's research goal. The primary purpose of this research is to examine the impact of UTM students' digital competency skills on adapting to IR 4.0 learning technologies. Therefore, the most suitable target population of the research is the students who acquire those skills. Since there are many universities in Malaysia, it is impossible to cover them all due to time constraints, so the population for the survey will only cover undergraduate students from Universiti Teknologi Malaysia (UTM) at Johor Bahru. Since UTM Johor Bahru has a relatively large number of students, not every student will participate in the survey. The focus will be on undergraduate students from year 1 to year four from only three faculties from the Faculty of Management, Science and Computing.

Table 1
Demographic Profile of Respondents

POPULATION	
Universiti Teknologi Malaysia at Johor Bahru *(Consists of 9 faculties)* • Faculty of Civil Engineering • Faculty of Mechanical Engineering • Faculty of Chemical & Energy Engineering • Faculty of Electrical Engineering • Faculty of Built Environment & Surveying • Faculty of Computing • Faculty of Science • Faculty of Social Sciences & Humanities • Faculty of Management	
Total Number of Undergraduates	**16,090**

According to Table 1 above, the target population are undergraduate students from 3 faculties, Management, Science and Computing, from year 1 to year 4. Due to time and financial constraints, a sampling method was selected to conclude the sample obtained from the population. The respondents for the survey were chosen using a random sampling method. Random sampling is a probability sampling method that ensures that each individual or thing in the population has a distinct and equal likelihood of being chosen as a study sample. This sampling technique was appropriate for this study because all UTM undergraduate students are known to be familiar with digital technologies, tools and skills. The sample is selected from a population. According to Raosoft software, 376 respondents were selected as the sample to obtain reliable data, with a 95% confidence level and ±5% margin of error accepted to carry out the descriptive analysis. A quantitative research approach will be used in this study to evaluate the relationship between digital competency skills and UTM students' adaptation to IR 4.0 technologies for learning. The research design will collect numerical data from a sample of UTM students using a standardized questionnaire. The questionnaire will consist of Likert scale items for evaluating students' views, mindsets and experiences with digital competency skills and their adaptation to IR 4.0 learning technologies.

Results and Discussions

Data Analysis

Four hundred thirty questionnaires were sent to the targeted respondents, UTM undergraduate students from the Faculty of Management, Faculty of Science and Computing, to reach a sample size of 376, as mentioned in Chapter 3. However, only 328 responses were successfully returned with a response rate of 76.28%, which did not meet the minimum sample size required. Skewness and Kurtosis values were used to determine the normality of the variables below in this study. The summary of the normality test results using skewness and kurtosis shows that all variables have fallen within -5 to +5, the acceptable normal distributed range. Meanwhile, the reliability test results and the values of Cronbach's alpha for all variables are more significant than 0.6, which can be

considered valid. Therefore, the results indicate that this instrument's data are typically distributed, precise and reliable.

Table 2
Summary of descriptive analysis

Variable	**Mean**	**Std. Deviation**
Information and data literacy	1.852	0.567
Communication and Collaboration	1.889	0.581
Digital content creation	1.914	0.561
Safety	1.945	0.571
Problem-solving	1.942	0.590

Objective 1 was analyzed using descriptive analysis to identify the level of digital competency skills among UTM students using mean and standard deviation. Based on Table 2 above, the mean value for all statements falls within the range of 1.852 to 1.945. The safety and problem-solving skills variable recorded the highest mean scores at 1.945 and 1.942. At the same time, information and data literacy recorded the lowest mean score at 1.852.

The Pearson correlation method was used to address objective 2, which evaluates the relation between the digital competency skills (information and data literacy, communication and collaboration, digital content creation, safety and problem-solving) and the dependent variable (adaptation of IR4.0 learning technologies).

Table 3
Pearson correlation

Adaptation of IR4.0 learning technology	Pearson correlation Sig. (2-tailed) N	Information and data literacy	Communication and Collaboration	Digital content creation	Safety	Problem-solving	Adaptation of IR4.0 learning technology
		0.396** 0.000 328	0.348** 0.000 328	0.251** 0.000 328	0.297** 0.000 328	0.300** 0.000 328	1 328

Based on Table 3 above, the results of the Pearson correlation test show that the sig (2-tailed) value between the dependent variable and all the independent variables is 0.000, which is less than 0.05. These results suggested that the digital competency skills, which are information and data literacy, communication and collaboration, digital content creation, safety and problem-solving, are significant and positively correlated with the adaptation of IR4.0 learning technologies. The highest correlation coefficient is information and data literacy, with a correlation value 0.396. Therefore, it is more correlated with the adaptation of IR4.0 learning technologies. The lowest correlation coefficient is digital content creation, with a correlation value 0.251.

Table 4
Multiple regression analysis model

Adaptation of IR4.0 Learning Technologies			
Model	Standardized Coefficient (Beta)	t	Sig. (2-tailed)
(Constant)		5.972	.000
Information and data literacy	.311	3.460	.001
Communication and Collaboration	.100	1.151	.251
Digital content creation	-.077	-.964	.336
Safety	.045	.588	.557
Problem-solving	.040	.480	.631

Table 4 shows that only one variable has a relationship and can directly explain the significance between the independent and dependent variables (Adaptation of IR4.0 learning technologies). The variable of significance with the adaptation of IR4.0 learning technologies is information and data literacy due to the result of significant levels being below the alpha value of 0.05, which is 0.001. In this study, the information and data literacy value can be noticed based on the standard beta (β) value, 0.311 and the t value of 3.460. Moreover, information and data literacy have proven to have a positive relationship with the adaptation of IR4.0 learning technologies in this research.

The first objective of this study is to identify the level of digital competency skills among UTM students. According to Khan et al (2021), the relevance of some digital skills shifts depending on the environment and the state of the technology. Therefore, it is crucial to analyse the impact of digital competency skills, which are essential to further this study and other objectives. Table 2 shows that students' safety and problem-solving skills have more impact, with a high mean score of 1.945 and 1.942, respectively. At the same time, information and data literacy skills had the lowest mean score of 1.852, showing less impact. The impact of these digital competency skills determines how prepared students are for the digital technologies evolving in the modern world. Students can contribute to the future by adapting or strongly influencing these skills.

The second objective is to investigate the factors that affect adapting digital competency skills towards IR4.0 learning technologies. Implementing Industry 4.0 will be challenging since it will be hard to identify new individuals with the digital abilities needed to handle new systems and adjust them to evolving technology (Khan et al., 2021). However, it is crucial to understand how institutions can enhance learning experiences for students to make them more engaging in the classroom. Table 3 shows that all the independent variable correlation values fall under the positive number between 0.251 and 0.396, and the sig. (2-tailed) value lower than 0.05. Therefore, the results show that all five digital competency skills have a significantly weak positive relationship towards adaptation of IR4.0 learning technologies. Based on these results, information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving skills relatively affect the IR4.0 learning technologies.

Finally, the third objective of this study is to measure the relationship between digital competency skills and adaptation of IR4.0 learning technologies among UTM students. Students in the current generation belong to a multitasking digital era and are consistently prepared to embrace advancements in the virtual world (Ismail et al., 2020). So, by understanding the relationship between these skills and IR4.0 learning technologies, institutions get a clear picture of setting up their learning environment. Table 4 shows that only one variable has a relationship and can directly explain the significance between the independent and dependent variables (Adaptation of IR4.0 learning technologies). The significant variable with the adaptation of IR4.0 learning technologies is information and data literacy due to a significant level below 0.05, which is 0.001. Meanwhile, the other four non-significant variables, Communication and collaboration, Digital content creation, Safety and Problem-solving, did not directly affect the adaptation of IR4.0 learning technologies.

Conclusions

In conclusion, this study explored the impact of UTM students' digital competency skills on adapting to IR 4.0 learning technologies. The findings indicate that students exhibit varying impacts on digital competency skills, with safety and problem-solving skills having the highest impact. The investigation into factors affecting adaptation revealed weak but significant positive relationships between digital competency skills and the adaptation of IR4.0 learning technologies. Information and data literacy are directly and significantly related to adaptation, while other skills have indirect impacts. As for the recommendations, future research should focus on specific aspects of digital competency skills and their impact on IR 4.0 adaptation, exploring socio-cultural influences and conducting longitudinal studies. Meanwhile, for educational institutions like UTM, integrating digital competency training across disciplines, ensuring robust infrastructure, and fostering a continuous learning culture is crucial. Initiatives should be inclusive, providing equitable access and support for all students.

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