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Predictors of AI Literacy and Productivity: Instrument Development, Scaling and Validation

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ABSTRACT

Artificial Intelligence (AI) literacy refers to the degree of knowledge, skills, and ability that a person needs to effectively develop, manage, and understand the capabilities of AI in a variety of fields, including education. These days, the idea of AI is gaining popularity and needs further study. Nevertheless, prior research indicates a lack of studies on AI literacy, particularly regarding its determinants and impacts. Therefore, the objective of this study is to establish and validate an instrument that can determine AI literacy and its productivity. The study covered several stages of empirical phases and a content validity evaluation. A set of variables was chosen based on previous studies. Then, a pilot instrument was developed according to the variables chosen. Lastly, the instrument was validated using an expert review method. The examination of the reliability and face validity of potential responders had been done. Therefore, a valid instrument consisting of eight variables and forty-five items was developed.

INTRODUCTION

Artificial intelligence (AI), which is rapidly evolving and being used in a variety of areas, such as literature and healthcare, is becoming an essential component of daily life (Al-Mughairi & Bhaskar, 2024; Biagini et al., 2024; Laupichler et al., 2023; Southworth et al., 2023). AI is defined as the capacity of computers to carry out intellectual tasks, including learning and problem-solving, which are often associated with human thought processes (Alzahrani, 2023; Chen et al., 2022). Al is an endeavor to gather and integrate diverse data, evaluate data, and explore different ways to share the outcomes. It gathers data from several sources, categorizes it, and presents it in accordance with its rules (Bancoro, 2024; Duan & Da Xu, 2012; Zhang & Lu, 2021).

AI has changed society throughout the years by altering how people work and view their surroundings and by assisting in the acquisition of information (Huda et al., 2023). AI has become widely used as a result of its applications in daily tasks and the creation of applications in many industries, demonstrating its potential to enhance quality and efficiency in everyday life (Bancoro, 2024). It illustrates that many people now utilize AI to help with a variety of work or fields. AI as well will have many applications, which will probably lead to the development of new approaches in education (Chai et al., 2021; So et al., 2020). Therefore, by making AI literacy a crucial academic competency, educational institutions should provide a chance to improve students' critical thinking abilities along with their understanding of AI (Biagini et al., 2024; Kandlhofer et al., 2016; Luckin et al., 2022; Ng et al., 2021).

The term "literacy" describes unique approaches to reading and writing that are used to understand or convey concepts and ideas through writing within a specific environment (Chiu et al., 2024; Keefe & Copeland, 2011). Literacy is primarily about knowledge and is closely related to abilities. Literacy, in general, is more about understanding whereas ability is more about using the information in a useful and efficient manner. It concentrates on an AI user's productivity and is associated with attitude and confidence (Chiu et al., 2024; Falloon, 2020). AI literacy is a set of abilities that enable people to utilize and evaluate AI systems, along with interact and collaborate with them (Chiu et al., 2024; Long & Magerko, 2020). The skills students need to comprehend and apply AI in a range of private and professional contexts are provided by AI literacy. Knowledge of AI will become as crucial as skills in writing, math, and reading, implying a significant shift in the way education is provided (Walter, 2024; Zhang et al., 2023).

AI literacy includes knowledge of the ethical and legal elements of AI, including flaws in AI and ethical principles, along with fundamental concepts such as deep learning, massive data, computer vision, computer voice, and natural language processing (Chiu & Sanusi, 2024). Understanding AI literacy levels is crucial for several reasons. It facilitates the identification of challenges and gaps in AI literacy, enabling specific efforts to effectively overcome these gaps. Therefore, the objective of this study is to establish and validate an instrument that can determine AI literacy and its productivity. The first step is to discuss AI literacy in several context such as education and also how its impact the productivity of students. Next, results and approach were then discussed. Finally, the discussion and the basis for future study are emphasized.

LITERATURE REVIEW

AI Literacy in Education

AI literacy was developed via years of media understanding, computational thinking, and digital readiness. The set of skills and knowledge known as AI literacy allows individuals to interact with AI tools and systems in a way that is both safe and ethically appropriate in an increasingly technologically advanced society (Mills et al., 2024). Every effort to teach people about AI must have encountered the issue of what exactly qualifies as AI literacy. utilizing AI concepts for evaluation, applying AI concepts for problem-solving, and implementing AI concepts for understanding the actual world are the three components that make up the authors' suggested definition of AI literacy (Kong et al., 2021).

AI is currently being used widely in a range of educational contexts, opening up many new opportunities for educational advances (Cheng et al., 2020; Du et al., 2024; Hwang et al., 2020; Wang et al., 2020). The technology associated with artificial intelligence is transforming and expanding social interaction areas in all directions. This shift impacts education in social interaction areas. AI in education has introduced new methods of instruction and learning that are being tried out in different circumstances (Dergunova et al., 2022). Artificial Intelligence in Education (AIEd) is the term for the use of AI in educational contexts. It has gained popularity as a result of improvements in computer and information processing techniques.

About 30 years ago, AIEd emerged, positioning AI as a powerful tool for facilitating innovative approaches to educational research, technology innovation, and instructional design that would not be possible inside traditional educational frameworks (Holmes, 2019; Hwang et al., 2020; Shofiah et al., 2023). AI in education has opened up new possibilities for developing technology-driven learning environments and applications as well as for producing successful learning experiences (Kay, 2012; Shofiah et al., 2023).

Through the rapid developments in AI, applications of AI in education have gained even more attention from researchers in the fields of education and computer science in recent years. It is predicted that more studies will be conducted that apply AI to educational settings and explore methods of teaching and promoting AI knowledge at every level of education (Hwang et al., 2020). Giving each student individualized learning help or advice based on their academic situation, preferences, or characteristics is one of the most important goals of AI in education (Hwang, 2014; Hwang et al., 2020). AI in education, has opened up new possibilities for creating effective learning exercises and improving technologically enhanced learning environments or applications (Hwang et al., 2020; Kay, 2012).

AI literacy, which captures people's knowledge and comprehension of AI ideas and applications, is a crucial cognitive component in AI education (Chai et al., 2021; Du et al., 2024; Lin & Van Brummelen, 2021; Ng et al., 2021). Long and Magerko (2020) and Du et al. (2024) pointed out that literacy has historically been linked to people's access to information, and they proposed that understanding AI is a crucial part of AI literacy, even if they do not specifically highlight AI philosophy in their definition. AI literacy should be taught to all students, according to experts, not just those who plan to work in computer science (Klein, 2023). In order to use AI applications and technologies effectively, users must possess the skills and knowledge required by AI literacy. Understanding the background of these technologies, questioning their development and use, and adopting a fair viewpoint are all components of AI literacy. Being able to identify the benefits and limitations of AI is another requirement for making wise choices about its usage. In educational context, both instructors and students can benefit from learning AI literacy, which enables them to navigate a technologically advanced society without needing technical expertise (Crabtree, 2023).

AI Literacy and Productivity

Productivity is defined as the level at which a worker, business, or nation produces things and the quantity produced relative to the time, effort, and financial resources needed to generate them (Hanushek & Ettema, 2017; Linna et al., 2010; Shukry et al., 2023). Another definition of productivity is it is measures how well a person, equipment, manufacturing, or system transforms inputs into valuable outputs. For the majority of people, productivity is a goal that is clear to both personally and the companies where the person works. People may feel that their productivity is a direct indication of their success in life and it feels like an acknowledgment of their achievement (Perry, 2023). The definitions of productivity in education include registrations, certificates, or credit hours, rate of graduation as well as the time to graduation, cost per credit hour, credit hours per faculty person and even "profitability" per faculty member, according to a few earlier studies. The development of "strong measurable indicators of either output or productivity" in the field of education was reportedly the subject of limited agreement (Hanushek & Ettema, 2017; Massy et al., 2013; Shukry et al., 2023).

Since AI is becoming more and more important, it is vital that everyone learn more about it, especially students at universities who will serve as future leaders and professionals of the rapidly evolving global community. The application of AI in higher education by students at universities has been the topic of the most significant research (Asio, 2024; Crompton & Burke, 2023). Participating in AI at university gives students the opportunity to learn about the AI-driven world, contribute to its advancement, and make informed decisions that will affect their future studies. This is accomplished by helping these students become more AI literate. Students who comprehend AI literacy are also more capable of analyzing and

evaluating the information and data they encounter during their studies (Asio, 2024). Students' productivity will rise when they include AI literacy in their studies.

Through the ability to distinguish between accurate and misleading information, AI literacy promotes critical thinking and a research-based approach in students (Asio, 2024). Enhancing university students' productivity is one area where AI literacy has enormous potential (Cardon et al., 2023). Presenting AI concepts to students also lowers barriers that exist for AI literacy and makes it feasible to spread the knowledge about it to as many people as possible, thereby preparing them for the AI revolution (Chaka, 2023; Kong et al., 2024; Kong et al., 2021; Long & Magerko, 2020). It is essential to increase people's ability to use readily accessible AI technologies and find solutions for problems they encounter in their daily lives. It makes it possible for students to collaborate with AI, transforming them from mere users into active members of the AI community (Kong et al., 2024; Laupichler et al., 2023).

The application of AI technology will increase even more during the coming years. When students learn advanced AI concepts early on and develop broader critical thinking skills, they gain independence in navigating an AI-integrated world. Students can guide and oversee AI to promote widely accepted security, productivity, and ethics rather than just being mere consumers (Activate Learning, 2024). AI literacy is important because it gives students the skills they need to navigate the expanding field of AI and better prepares them for future careers that commonly require AI technology (Poth, 2024). Furthermore, including AI literacy in students' daily lives will make their work easier by giving them the skills to incorporate AI into their assignments, which will ultimately improve their productivity.

METHODOLOGY

The approach used in the study was taken from and modified from previous studies (Erfanmanesh et al., 2012; Shukry et al., 2023). The first step of the methodology is to determine the study's predictors and their impacts such as AI literacy, Artificial Intelligence and Productivity. Then, the instrument was created based on the predictors and the impacts that be found in the previous studies. Figure 1 shows the overall research methodology of this study.

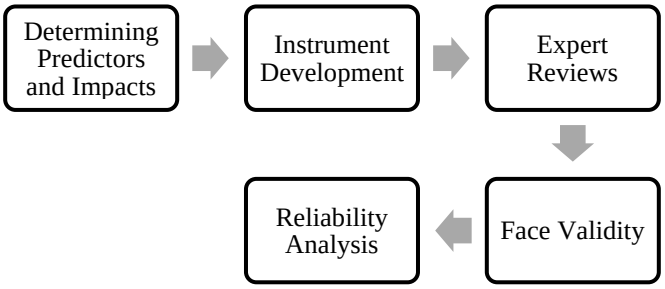

Figure 1: Research Methodology of the study

Determining Predictors and Impacts

The determinant of the predictors and impacts for this study is based on Systematic Literature Review (SLR) concepts. The SLR concepts consist of three processes which are, firstly, the SLR starts with an acknowledged journal, then it searches backwards for relevant journals and lastly, it searches forward to see if any articles need to be cited (Rosman et al., 2019; Webster & Watson, 2002). The terms used for searching for a suitable article are "Artificial Intelligence", "AI Literacy", "Productivity", "AI applications" and "AI Literacy in educational context". The previous studies were chosen and were searched in online databases such as Emerald Insights, Scopus, IEEE Explores, Research Gate and ProQuest. The key

components of finding relevant research to use in this study are the abstract, introduction, literature review, and conclusion. There were about 120 papers that were found to have the potential to be helpful for additional research. Based on the previous research, there were eight variables that have been chosen which are cognitive absorption, attitudes towards AI, digital divide, effort expectation, performance expectation, awareness of AI, AI literacy and productivity.

Instrument Development

The instrument was created by adopting and modifying existing instruments from previous studies. The instrument is developed in two steps, which are the construction of the instrument's foundation and contents and the instrument's scales (Rosman, Ismail, et al., 2022; Rosman, Razlan, et al., 2022; Shukry et al., 2023). Furthermore, the instrument has four key components. The ethical declaration and possible effects of the inquiry on the respondents' well-being are included in the first main part. The demographic data of the responders is gathered in the second part. Lastly, responses were then gathered according to every factor and determinant in the following part. Table 1 below shows the instrument's development of this study.

Table 1: Instrument Developments

Variables	**Number of Items**	**Sources**
AI Literacy ● Apply AI ● Understand AI ● Detect AI ● AI Ethics	 4 4 4 4	(Long & Magerko, 2020; Ng et al., 2022; Wang et al., 2022)
Productivity	4	(Torkzadeh & Doll, 1999)
Cognitive Absorption	4	(Agarwal & Karahanna, 2000)
Digital Divide	5	(Shukry et al., 2023)
Attitudes Towards AI	4	(Grassini, 2023; Schepman & Rodway, 2020)
Effort Expectation	4	(Heng, 2023; Sair & Danish, 2018)
Performance Expectation	4	(Sair & Danish, 2018)
Awareness of AI	4	(Wang et al., 2022)

Expert Reviews

The objective of doing the expert reviews is to see whether the items and variables that were used are suitable or not and to confirm whether the items are relevant to the variables. In order for the expert to validate the items and variables, the form for expert reviews was created. The form consists of the variables and the items and the experts need to comment on the items and whether they need to be changed or are suitable enough to be used.

Face Validity

The objective of face validity is to confirm that the items are suitable and meet the purpose of the study. The audience that needs to do the face validity is the undergraduate students in universities. Face validity enables the research team to enhance the instrument's effectiveness and efficiency while also raising the chance that the targeted respondents will reply more frequently by customizing the instrument to their interests and preferences (Shukry et al., 2023).

Reliability Analysis

Reliability analysis was carried out to verify the instrument's reliability before making the necessary adjustments and improvements as recommended by the expert review and face validity procedures (Shukry et al., 2023).

RESULTS AND DISCUSSIONS

Demographic of The Expert Reviews

Five experts were involved in the validation of the instruments in this study. All of the experts are the professional lecturers and academics in the universities. They have at least a doctorate certification and qualification in the courses such as information management system, computer engineering and also computer sciences and they also have at least 10 years of working experience as a lecturers and academics. Table 2 shows the demographic profiles of all the five experts that were involved.

Table 2: Demographic profiles of Expert Reviews

Experts	Academic Qualification	Position	Academics and working experiences
1	PhD	Senior Lecturer	More than 10 years
2	PhD	Senior Lecturer	More than 10 years
3	PhD	Senior Lecturer	More than 10 years
4	PhD	Senior Lecturer	More than 10 years

The experts who were chosen are also actively involved in publishing studies related to their areas of expertise. In order for the experts to validate the instruments, the form consists of the items and variables were given to them in order for them to checked the connection between the clarity if the instruments and the content relevance of the instrument and they need to complete the validation within two weeks.

Content Validity

To calculate the content validity index for this study, calculation is based on the previous research from Polit & Beck (2006). For content clarity of this study, the mean of the i-CVI is 1, S-CVI/UA is 1 and the mean of the expert proportion is 1 where it is shown that the instrument of this study has a high evaluation content clarity. Table 3 shows the content validity index for this study.

Table 3: Content Validity Index

Item	Content Clarity	Content Relevance
Mean I-CVI	1	1
S-CVI/UA	1	1
Mean Expert Proportion	1	1

For content relevance, the mean of the i-CVI is also 1, S-CVI/UA, is also 1 and the mean of the expert proportion is 1, showing that the content relevance of this study also has a high evaluation content relevance.

Face Validity

After that, face validity is the next step to validate the instrument. There were 10 students with a bachelor's degree and diploma students from Universiti Teknologi Mara (UiTM) Kelantan branch who were chosen to do the face validity. Based on the face validity results from these 10 students, there were no recommendations and all of the students agreed that the instruments used in this study is easy to understand and relevant to the study's objective.

Reliability Analysis

After the content and face validity, the last step to validate the instruments is reliability analysis. Reliability analysis of instruments was done after the content validity from the experts, face validity from the students, correction and also adjustment of the items after the expert's and student's recommendations. Then the pilot study was done to verify the instrument's reliability. The questionnaires were sent to the students from the UiTM Kelantan branch and 38 respondents answered the questionnaire of this study. Then to analyze the data received from the respondents, a Statistical Package for Social Science (SPSS) version 26 was used. The Cronbach's Alpha coefficient was used to determine whether the items and variables were reliable or not for this study. The supposed reliability for each variable is 0.7 and above (Nunnally, 1975). Therefore, the result for the Cronbach's Alpha coefficient for this study was between 0.772 and 0.949 which is considered as an acceptable value. Table 4 shows the reliability analysis for this study.

Table 4: Reliability Analysis

Variable	Number of Items	Cronbach Alpha Coefficient
Apply AI (APAI)	4	0.843
Understand AI (UNAI)	4	0.772
Detect AI (DTAI)	4	0.894
AI Ethics (AIET)	4	0.803
Productivity (PRO)	4	0.892
Cognitive Absorption (CA)	4	0.831
Digital Divide (DD)	5	0.806
Attitude Towards AI (ATAI)	4	0.898
Effort Expectation (EE)	4	0.888
Performance Expectation (PE)	4	0.949
Awareness of AI (AOAI)	4	0.860

Final Instruments

The table below shows the final instruments after the expert reviews, content validity, face validity and reliability analysis. The final instruments were made after the comments of the experts, recommendations and the result of the analysis.

Table 5: Final Instruments

Variables	Item Code	Items
Apply AI (APAI)	APAI1	I can operate the AI application to complete the daily tasks of my studies.
	APAI2	I use AI applications to complete my task easily.
	APAI3	I use AI applications meaningfully to achieve my goals.
	APAI4	I find AI application useful for my daily task.
Understand AI (UNAI)	UNAI1	I know the definition of artificial intelligence.
	UNAI2	I can assess the limitations of using an AI.
	UNAI3	I can assess the opportunities of using an AI.
	UNAI4	I can evaluate myself on the advantages of artificial intelligence technology.
Detect AI (DTAI)	DTAI1	I am able to determine whether I am working with an artificial intelligence-based application.
	DTAI2	I can differentiate between devices that utilize AI and those that do not.
	DTAI3	I can distinguish if I interact with an AI or a “real human.”
	DTAI4	I can identify the AI technology in the applications and products I use.
AI Ethics (AIET)	AIET1	I can consider the implications of deploying AI for society
	AIET2	I can incorporate ethical considerations when deciding whether to use data provided by AI.
	AIET3	I can analyze AI-based applications for their ethical implications.
	AIET4	I am alert to privacy and information security issues when using AI applications or products.
Productivity (PRO)	PRO1	AI applications help me to increase my productivity.
	PRO2	AI applications helps me come up with new ideas.
	PRO3	AI applications allows me to accomplish more work than my usual pace.
	PRO4	AI applications helps me to try out innovative ideas.
Cognitive Absorption (CA)	CA1	I notice that time flies when I using AI technology.
	CA2	I am immersed in the tasks that I am performing while using AI technology.
	CA3	I enjoy using AI technology.
	CA4	I have fun interacting with AI technology.
Digital Divide (DD)	DD1	I have adequate access to AI applications.
	DD2	I am not afraid of AI technology.
	DD3	I have a good access to Internet facilities.

	DD4	I am competent in dealing with technology.
	DD5	I have adequate technical skills to deal with AI applications.
Attitude Towards AI (ATAI)	ATAI1	Using AI is a good idea.
	ATAI2	AI is vital to enhancing my knowledge.
	ATAI3	My attitude towards AI is very positive.
	ATAI4	I have a positive feeling toward AI.
Effort Expectation (EE)	EE1	Learning AI technology is easy for me.
	EE2	AI technology is understandable.
	EE3	It will be easy for me to become skillsful by using AI technology.
	EE4	Overall, using AI technology is easy.
Performance Expectation (PE)	PE1	Using AI technology improves my efficiency in my daily task.
	PE2	Using AI technology enables me to do my tasks conveniently.
	PE3	Using AI technology would enhance my effectiveness in my daily tasks.
	PE4	Using AI technology would improve my task productivity.
Awareness of AI (AOAI)	AOAI1	I have heard about AI.
	AOAI2	I know how AI technology can help me.
	AOAI3	I think AI will be a useful tool for my task.
	AOAI4	I know that AI technology is important for my task.

DISCUSSION

Through the rapid developments in AI, applications of AI in education have gained even more attention from researchers in the fields of education and computer science in recent years (Hwang et al., 2020). AI literacy is important for the students because it provides the skills and information required to effectively use AI applications and technology. Understanding AI literacy can help learners and educators navigate an increasingly technologically advanced environment without needing technical expertise (Crabtree, 2023).

This study were created to developing and validating tools to asses university students' AI literacy. There were eight variables that were involved in this study which are AI literacy, productivity, cognitive absorption, digital divide, attitude towards AI, effort expectation, performance expectation and awareness of AI. The instruments of this study can be used see the productivity and performance of the students based on the way that they used AI application and technology properly and ethically. Instrument creation, expert reviews, face validity, pilot research, and reliability analysis are the steps that were carried out during this validity of the instruments. After that, data will be gathered in order to further validate the items and variables. Undergraduate students enrolled in computer, informatics, and mathematics courses at UiTM are the study's anticipated audiences. Students will gain a better understanding of AI literacy and the ability to use AI applications and technology in an ethical and correct manner, which will increase their productivity. In addition, the conceptual framework and AI literacy study can be expanded using this instruments.

CONCLUSION

In conclusion, this study were created to evaluate a reliable tool for assessing the connection between productivity and AI literacy. AI literacy, productivity, cognitive absorption, digital divide, attitude toward

AI, effort expectation, performance expectation, and awareness of AI are the eight variables that were found. A number of procedures were carried out, including a pilot study, reliability analysis, content validity, face validity, instrument development, expert review, and the SLR technique's application to identify the topic's determinants and impacts. It may be determined that the final instrument, which consists of forty-five items, is adequate for use in a study on AI literacy and productivity for students' knowledge. Undergraduate students enrolled in computer, informatics, and mathematics courses at UiTM are the study's anticipated audiences. Next, the limitation that were recognized on this study is the lack of research focusing on the AI literacy.

We proposed that the future studies and also academicians can focused more on AI literacy as it is one of the important skills and abilities that students needs to learn and adapt in order for them to use AI application and technology properly. Another limitation that can be recognized is the selection of respondent and universities. For this study, the respodents is from only one university which is Universiti Teknologi Mara. We hope that the future research will be more focusing on another universities and also another courses.

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