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Towards Educator 4.0: Technology Competency-Based Teaching
(Ke Arah Pendidik 4.0: Pengajaran Berasaskan Kompetensi Teknologi)

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ABSTRAK

Pendidik 4.0 ialah konsep baharu yang menerangkan ciri-ciri bakal pendidik yang mampu mengendali dan mengadaptasi pelbagai teknologi pintar ke dalam kaedah dan strategi pengajaran. Memandangkan sistem pendidikan telah berubah dengan pesat berikutan transformasi teknologi digital dan pintar, pendidik khususnya di Institusi Pengajian Tinggi perlu meningkatkan kemahiran mengajar serta kompeten bagi memenuhi keperluan pelajar generasi baharu. Masih tidak banyak isu berkaitan Pendidik 4.0 yang dibincangkan dan bagaimana ianya boleh diukur. Ini disebabkan oleh literatur yang terhad di peringkat global, justeru wujud keperluan untuk membangunkan instrumen dan model baharu untuk mengukur kompetensi Pendidik 4.0. Teori Literasi Teknologi dan DigCompEdu telah diadaptasi untuk membangunkan model instrumen ini. Konstruk seperti literasi Teknologi 4.0, sumber Teknologi 4.0, dan pemerkasaan pelajar telah dikenal pasti lalu digunakan untuk mengukur tahap kompetensi 4.0 dalam kalangan pendidik. Data responden daripada institusi Pra-Universiti, diwakili oleh pensyarah Kolej MARA dan Kolej Profesional MARA di seluruh semenanjung Malaysia, dikumpul menggunakan gabungan kaedah persampelan bukan kebarangkalian dan kaedah pensampelan mudah. Pendekatan PLS-SEM telah digunakan untuk mengesahkan model instrumen ini. Dapatan kajian menunjukkan bahawa instrumen yang dibangunkan adalah sah dan kesemua konstruk mempunyai sumbangan yang positif terhadap kecekapan Pendidik 4.0. Kesemua konstruk adalah baik untuk mengukur kompetensi Pendidik 4.0. Dapatan kajian juga dapat memberikan pemahaman yang lebih baik tentang kompetensi Pendidik 4.0 yang berkaitan dengan konteks kajian. Selain itu, kajian ini juga dapat menyumbang kepada penambahan literatur tentang kompetensi 4.0 Pendidik.

Kata kunci: Pendidikan 4.0; Pendidik 4.0; Pra-Universiti; Kompetensi Mengajar; Teknologi 4.0

ABSTRACT

Educator 4.0 is a new concept that describes the characteristics of future educators capable of handling and implementing various smart technologies into their teaching methods and strategies. Since the education system has rapidly changed due to the digital and smart technology transformation, educators especially in Higher Learning Institutions are required to upgrade their teaching skills and become more competent to meet the needs of the new generations of students. There is not much discussion on Educator 4.0 and how it can be measured. This is also due to the limited literature globally, thus there is a need to develop new instruments and models to measure the 4.0 Educators' competency. The theories of Technology Literacy and DigCompEdu were adapted to develop this new instrument model. Factors and constructs such as Technologyy 4.0 literacy, Technology 4.0 resources, and student empowerment were identified and used to measure the level of 4.0 competencies among the educators. The data from the respondents in Pre-University Institutions, represented by Kolej MARA and Kolej Profesional MARA lecturers on the east coast of Malaysia, was collected using a non-probability sampling method combined with convenience sampling. A PLS-SEM approach was used to validate this new instrument model. The findings reveal that the instruments developed were valid and all constructs have a positive contribution towards Educator 4.0 competency. All constructs were good at measuring the Educator 4.0 competency. The findings of the study will provide a better understanding of educators' 4.0 competency regarding the context of the study. Besides, this study will enrich the literature on 4.0 Educators' competency.

Keywords: Education 4.0; Educator 4.0; Pre-University; Teaching Competency; Technology 4.0

INTRODUCTION

Educator 4.0 is a concept introduced by Abdulrazeq et al. (2016) to describe the characteristics of future educators who can handle various technologies and implement them efficiently in their teaching. The term Educator 4.0 is still limited in use either at the national or global level. The most recent study that uses this term is the study by Peredrienko, Oxana and Yaroslova (2020). In the study, it was explained that Educator 4.0 is a concept created as a response to the needs of the Industrial Revolution 4.0 and it is easier to describe the characteristics of teaching and learning by educators based on this technological revolution. The ability of educators to go through the digital era in the educational process and their willingness to adapt to the frequently changing educational environment posses an important issues to discuss (Peredrienko et al. 2020). Changes to the teaching style need to be done frequently to ensure that lecturers remain competent and that their teaching skills are in line with the latest education system requirement (Gutiérrez-Castillo et al. 2023; Karlen et al. 2023). To achieve an excellent level of teaching competency, it needs to be supported with the use of various technologies (Ng et al. 2023; Lin et al. 2023; Mirete et al. 2020; Barragán-Sánchez 2020; Wang et al. 2021).

Educators 4.0 are individuals who can master the latest technology skills, are knowledgeable and can solve technology-related problems such as technical problems, security, and control systems. They also understand and adhere to the ethics of online technology use. This knowledge and expertise should then be used to guide and empower students' skills. However, there is limited research conducted to measure the level of Educator 4.0 competencies among lecturers. The exposure and awareness regarding the characteristics of Educator 4.0 is low and lacks attention. There is a study done in Pakistan, and it is found that the limitation of knowledge regarding the use of 4.0 technologies caused their education system to be stuck at the stage of Education 2.0 progress (Butt et al. 2020). This statement is supported by Alda et al. (2020) who reported that in the Philippines, they need more support from the government in providing infrastructure that can help the implementation of Education 4.0. This limitation causes the level of competency in the use of 4.0 technologies to be low and difficult to measure. This includes assessing whether educators have the criteria and characteristics required for Educator 4.0. From all of these problems, it is clear that there are limited studies regarding Educators 4.0 competency globally specifically in Asia countries. Therefore, a new instrument and model were built to identify the appropriate elements and constructs that can measure and contribute to the level of competency for Educator 4.0. With the use of this tool, educational institutions will be able to assess the Educator 4.0 competency levels of their lecturers and teachers, provide them with workshops and relevant training, improve their facilities, and recognise their expertise. These skilled educators can then collaborate with other institutions or work as peer tutors, sharing their knowledge and abilities.

LITERATURE REVIEW

To understand the various determinants that may influence Educator 4.0 competencies, this section discusses various theoretical frameworks that are used in measuring teaching competencies aligned with the use of 4.0 technologies. Two prominent models and theories are adapted and integrated into this Educator 4.0 competencies framework model which are DigCompEdu (Redecker 2017) and Technology Literacy (Hovde & Renguette 2017). The DigCompEdu model only measures the basic ability to use digital technology. This study measures the use of Technology 4.0. Since Technology 4.0 is a relatively new concept, it is crucial to ascertain each educator's level of knowledge, understanding and awareness regarding it before evaluating other aspects of their teaching competency. Therefore, Technology Literacy theory is modified and adapted to the DigCompEdu model to build a more comprehensive instrument since it contains the necessary components to measure the use of the new terms of Technology 4.0 which explained the use of various combination of smart technologies. Therefore, the DigCompEdu model is adapted to build items and instruments to measure the competence of Educators 4.0 that are parallel to the teaching skills based on Technology 4.0.

TECHNOLOGY 4.0 LITERACY

Technology Literacy theory originally emphasized knowledge of digital technology concepts (Yang & Alicia 2022). In this study, the use of digital technology will be replaced by the term Technology 4.0 (Masdoki et al. 2021). This literacy refers to knowledge and understanding of the concept of Technology 4.0. Reisoğlu and Çebi (2020) explain educators who have an understanding and knowledge of technology are more likely to use technology frequently than in their teaching. This knowledge then becomes a good experience for them to upgrade their existing teaching methods. It also refers to the awareness and sensitivity of the educators in parallel with the technology used to the current needs (Mauco & Mars 2019; Jennett et al. 2003; Zhurakovskaya et al. 2020). It includes the level of readiness to accept and adapt to various technologies including smart technology in their daily life

(Lea 2020). Technology Literacy theory by Hovde and Renguette (2017) lists three important criteria to be measured, (i) technological knowledge; (ii) technological understanding, and (iii) technological awareness. Technological knowledge measures the capacity of individuals knowledge on technologies presence in their environment or daily lives, whereas technological understanding is the ability of an individual to use and comprehend the everyday technology they encounter. Technological awareness is a measure of a person's capacity to recognize issues and difficulties brought about by technology.

Literature shows that these three elements are important to represent technological literacy and they should have contributions to competencies (Reisoğlu & Çebi 2020; Sulaiman & Ismail 2020; Arbaa et al. 2017; Muin et al. 2020; Yang & Alicia 2022). By developing a new construct that will serve as a comprehensive assessment of Technology 4.0 literacy. Thus, these 3 elements should be adapted and modified to suits the new terms of Technology 4.0. To determine how this Technology 4.0 literacy could improve the educators' competency, a validation test should next be conducted. Thus hypotheses were developed:

H1: Technology 4.0 Literacy has a positive contribution to the competence of Educators 4.0

TECHNOLOGY 4.0 RESOURCES

Technology 4.0 resources are constructs adapted from the DigCompEdu model to measure individual skill levels in providing teaching resources and materials. It also measures the skill level of individuals in creating new resources through the use of various technology and sharing the resources produced for use by others. Digital resources and their applications have a significant influence on the acquisition of digital teaching competence (Guillén-Gámez et al. 2020). Redecker (2017) believes that an educator who is skilled in utilizing existing technology resources contributes to the improvement of teaching competence positively. The educator has an advantage in integrating resources and existing technology into their teaching techniques (Esteve-Mon et al. 2020). A study conducted by Dias-Trindade & Albuquerque (2022) shows that educators who are less skilled in using various technology resources especially smart technologies have a low level of competence while educational individuals who are active and skilled in using various technological resources have a higher level of teaching competence. One feature of Educator 4.0, according to Abdelrazeq et al. (2016), is the capacity to filter and extract different resources that the technology can access. In order to improve the learning experience, Educators 4.0 should also be able to use the chosen resources and creatively generate instructional materials. Hence, the second hypothesis would be:

H2: Technology 4.0 Resources has a positive contribution to the competence of Educators 4.0

STUDENTS' EMPOWERMENT

Student empowerment measures an individual's ability to use technology to enhance student participation and learning. This construct also measures the level of ability of individuals or teaching staff to produce teaching methods that are more personal or individualistic to ensure that the methods used can meet the needs of students with different levels of learning. It is the lecturer's responsibility to ensure that they can guide students to add both their skills (Pinto & Reis 2023). Past studies show that technology increases access to educators and students, providing more up-to-date learning resources and they can access the materials anytime and anywhere (Mcknight et al. 2016).

Educators in Higher Learning Institutions are responsible for being facilitators to students not only in imparting knowledge and teaching skills technically (Pinto & Reis 2023) but also in enhancing students' technological skills. Educators should also be able to guide students when facing technological challenges and solving any problems related to Technology 4.0. A study by Reisouglu & Cebi (2020) conducted on pre-service educators in Turkey, shows that every educator who has technology skills will indirectly benefit their skills to students. Research data shows that half of the respondents educators who have technology skills will use it to produce better teaching methods to attract the attention of their students. Thus, the third hypothesis would be:

H3: Student empowerment has a positive contribution to the competence of Educators 4.0

TEACHING COMPETENCY

The quality and competence of teaching in Higher Learning Institutions are very important to ensure effective learning outcomes in producing excellent students. Fulfilling the prerequisites and standards for a promotion or appointment is also crucial (Karlen et al. 2023). Numerous prior research has indicated that the utilization of technology is necessary to attain a high degree of teaching proficiency (Ng et al. 2023; Lin et al. 2023; Mirete et al. 2020). However, the extent of the use of Technology 4.0 can form a competent Educator 4.0, especially in Higher Education Institutions has not yet been proven. Thus an appropriate instrument model can be developed to measure the effect of each

construct on the competency level of educators in applying Technology 4.0 in their teaching known as Educator 4.0. Figure 1 shows a conceptual research framework for Educator 4.0 competencies. Three constructs; Technology 4.0 literacy, Technology 4.0 resources, and student empowerment were used to describe endogenous variables. The 4.0 competencies construct served as a representation of the exogenous variable. The influence of all three endogenous variables on the Educators 4.0 skills was then hypothesized.

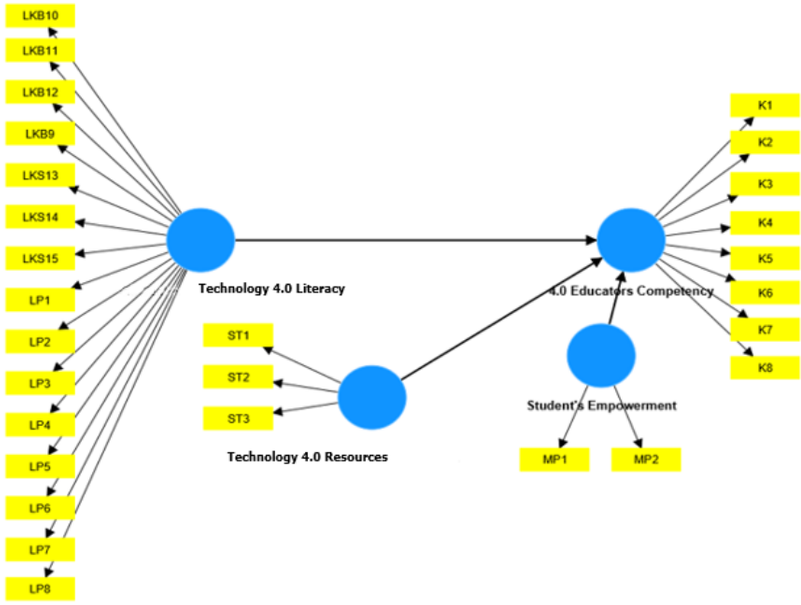

Figure 1 Educator 4.0 Competencies Research Framework

RESEARCH METHODOLOGY

Utilizing the purposive sample approach in conjunction with the non-probability sampling strategy, data were gathered from lecturers at Kolej MARA and Kolej Profesional MARA Pre-University Institutions throughout Malaysia. A self-administered method was being used to reach over 300 possible responders, with only 274 being collected with a complete filled-up questionnaire. The least sample size needed to analyze the study model is 103, according to the G-Power software, which was used to calculate the minimum sample size using the power of analysis as provided by Hair et al. (2017) with an effect size of 0.15, margin error of 5%, and power of 80% (Gefen et al. 2011). As a result, the sample size is adequate to evaluate the study's research model. Furthermore, every item was taken and modified from verified assessments from earlier research. Items for Technology 4.0 literacy are adapted from Technology Literacy Theory by Hovde and Renguette (2017), whereas Technology 4.0 resources, student empowerment and 4.0 competency were adapted from DigCompEdu model by Redecker (2017).

RESULT AND DISCUSSION

Smart PLS 4.0.9.9 was used to analyze the data and test the study's hypothesis. Smart PLS is appropriate for research with a predictive focus (Urbach & Ahlemann 2010). For this reason, Smart PLS was used in the study to make predictions. An outliers analysis, the common method variance, and the normality test should be part of an initial analysis that is done before looking at the study framework. If the study of exogenous and endogenous variables were measured using a single source of data that was obtained simultaneously, the Common Method Variance (CMV) needs to be addressed (Podsakoff et al. 2012).

To verify that there is no CMV problem in the study, both procedural and statistical methods were used (Podsakoff et al. (2003). The study measured exogenous and endogenous variables for procedural remedy using scales, ranging from 1 to 5. There is no bias from single source data if the variance inflation factor (VIF) is equal to or less than 3.3 after all variables were regressed against common variables using comprehensive collinearity

analysis (Kock 2015). This study's research produced a VIF of less than 3.3, which suggests that the CMV issue has not been present. As proposed by Hair et al. (2017) and Ngah et al. (2019), the study used software from Web Power Statistical Power Analysis online to determine whether the data were normal. The findings showed that the data was not multivariate normal, as indicated by Mardia's multivariate skewness ($\beta = 4654.309$, $p<0.01$) and multivariate kurtosis ($\beta = 1681.766$, $p<0.01$). As a result, we used the non-parametric analytic programme Smart PLS.

MEASUREMENT MODEL

Data analysis is divided into two phases: the measurement model and the structural model. The convergent and discriminant validity of the measurement model must be tested in the research. Testing for convergent validity involves looking for loadings greater than 0.5, composite reliability (CR) greater than 0.7, and average variance extracted (AVE) greater than 0.5 (Hair et al. 2017). Table 1 shows that every concept in the research framework satisfies the minimal threshold values, proving the study's convergent validity.

Table 1. Measurement Model

Construct	Item	Loading	CR	AVE
Technology 4.0 Literacy	LP1	0.655	0.870	0.690
	LP2	0.735		
	LP3	0.770		
	LP4	0.604		
	LP5	0.777		
	LP6	0.758		
	LP7	0.585		
	LP8	0.765		
	LKB9	0.821		
	LKB10	0.879		
	LKB11	0.877		
	LKB12	0.770		
	LKS13	0.862		
	LKS14	0.878		
	LKS15	0.829		
Technology 4.0 Resources	ST2	0.875	0.819	0.607
	ST3	0.818		
	ST4	0.620		
Student's Empowerment	MP1	0.860	0.873	0.775
	MP2	0.900		
4.0 Competencies	K1	0.602	0.890	0.506
	K3	0.750		
	K4	0.739		
	K7	0.616		
	K8	0.749		
	K9	0.647		
	K11	0.779		
	K12	0.783		

*Notes: ST1, ST5, MP3, MP4, K0, K2, K5, K6, K10 and K13 was dropped due to low loading

While there are numerous approaches to assess discriminant validity, the most recent research by Henseler et al. (2015) suggested that the Heterotrait-Monotrait (HTMT) ratio of correlation techniques be used in the investigation. Since none of the values in Table 2 deviate from the minimal value of 0.85, the study's discriminant validity has been satisfied (Henseler et al. 2015).

Table 2. Discriminant validity

	4.0 Competencies	Technology 4.0 Literacy	Student's Empowerment	Technology 4.0 Resources
4.0 Competencies				
Technology 4.0 Literacy	0.515			
Student's Empowerment	0.740	0.365		
Technology 4.0 Resources	0.823	0.501	0.540	

STRUCTURAL MODEL

To ensure that collinearity is not a serious problem in the study, the variance inflation factor (VIF) value must be less than 3.3 (Diamantopoulos 1994). VIF is not a serious issue in the study, as seen in Table 3, where all VIF values were below the threshold value established (Diamantopoulos 1994).

A bootstrapping strategy using 5000 resampling techniques was used for the hypothesis testing. The significance and confidence interval will be used to gauge the path coefficient estimates (Hair et al. 2017). The analysis revealed that the hypothesis was supported for H1 ($\beta = 0.108$, $t = 2.273$: LL = 0.027, UL 0.182, $p = 0.012$). In the case of H2, H2 was supported ($\beta = 0.197$, $t = 3.91$: LL = 0.114, UL 0.279, $p = 0$). H3 was likewise supported for ($\beta = 0.207$, $t = 4.173$: LL = 0.132, UL 0.293, $p = 0$). The results for each of the study's direct relationship hypotheses are shown in Table 3.

Table 3. Hypothesis Testing

Hypo	Relationship	Direct Effect, Beta	Se	Confidence Interval		T Value	P Value	Decision	VIF
				(LL)	(UL)				
H1	4.0 Tech Lit → 4.0 Comp	0.108	0.047	0.027	0.182	2.273	0.012	Supported	1.447
H2	4.0 Tech Res → 4.0 Comp	0.197	0.05	0.114	0.279	3.91	0	Supported	1.667
H3	Student's Emp → 4.0 Comp	0.207	0.049	0.132	0.293	4.173	0	Supported	1.512

CONCLUSION

The study analyzed the elements that contribute to measuring the 4.0 Educators Competencies. The study disclosed that the variable adapted from the Technological Literacy theory by Hovde and Renguette (2017) which is 4.0 Technological Literacy has a positive relationship with the 4.0 Educators Competencies. Therefore, adding the new construct from this theory could improve the measurement construct and knowledge element that need to be assessed. Thus, demonstrating the theory's ability to account for the variables influencing the 4.0 Educator Competencies. Hence, to increase the 4.0 competencies, the educator needs to have a good 4.0 technological literacy. Those elements could be raised by a better understanding and awareness among educators in Higher Learning Institutions on the importance of 4.0 technology. Thus, H1 was found supported.

For the H2, the study found that Technology 4.0 Resources also found to have a positive relationship with the 4.0 Educator Competencies. This finding corroborated the resolution from Guillén-Gámez et al. (2020). It records that, educators who actively use a variety of 4.0 technological resources in their teaching contribute to a better level of 4.0 competencies. Educators who have high access to 4.0 technology and frequently adapt the 4.0 tools in their teaching produce creative methods that attract more attention to students. The findings of this study was align with Wang et al. (2021) by stating that educators who integrate their teaching with 4.0 technology contribute to better skills and competencies. As a result, students will be more motivated and can also actively participate in class. Hence, H2 was supported.

For H3, it was found that student empowerment has a positive relationship with 4.0 Educator Competencies. As stated by GuillénGámez & Mayorga-Fernández (2020), educator who is highly integrated with 4.0 teaching will encourage their students to have good skills in operating the 4.0 technologies. The concept of self-learning or personalized learning methods can be developed and adapted according to student abilities. This can also encourage students to be active and participate in the learning process. Hence, the construct of student empowerment has a contribution that is positive towards the competence of Educators 4.0.

The findings of the study revealed the factors towards 4.0 Educator Competencies. This finding is good for the Higher Learning Institutions in enlightening their academician towards their teaching quality. It is anticipated that the work will help them to arrive a good programs such as training and workshops to improve educators' 4.0 teaching skills and methods.

THEORETICAL AND PRACTICAL IMPLICATIONS

This study can contribute to several practical aspects. The first contribution is to the production of the Educator 4.0 competency instrument, the addition of literature in the field of Education 4.0, and the addition to the study of the competency dimension. Due to the limitation of the Educator 4.0 competency instruments and model at the global level, this study is seen as an addition to a new, more practical model.

LIMITATIONS AND FUTURE STUDIES

This study uses quantitative analysis as the main analysis method. Questionnaires are the main instrument for obtaining data sources. Among other suggested methods is to carry out a combined method of quantitative analysis and qualitative to strengthen the actual study. By using a combination of quantitative and qualitative methods, the collection of data from respondents will be more varied and high quality. Experimental methods can also be done by using other constructs that are more appropriate to test the level of competence of Educators 4.0. Studies can be tested in different types of organizations and different levels of learning institutions. A more in-depth study is also suggested to be carried out to examine other constructs that are likely to be appropriate in measuring the Educator 4.0 competencies. Therefore, the expansion of this context is relevant and worthy of study.

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