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Research Article

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UTAUT model in teaching Biology: Structural Equation Modeling

Muhammad Sofwan*

Program PGSD, Universitas Jambi,
Jl. Jambi - Muara Bulian No.KM. 15, Mendalo Indah, Kec. Jambi Luar Kota, Kabupaten Muaro Jambi, Jambi
Corresponding Author: Muhammad.sofwan@unja.ac.id

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ABSTRACT

This study aims to examine the direct effect of the UTAUT model, educational policies and habits on Information and communication use (ICTuse). These dimensions were developed by proposing research indicators that have a partial and simultaneous impact. With a sample of 251 teachers in teaching Biology. This study uses Structural Equation Modeling (SEM) through partial least square approach (PLS). The findings of the current study revealed that the strongest relationship emerge between performance expectancy and behavioral intention while the least robust correlation was between social influence and behavioral intention. The model was fit with Standardized Root Mean Square Residual of 0.060. Based on research findings, this study provides implications for policies/programs that aim to promote teachers to adopt ICT-based teaching. From a managerial and institutional perspective, this research has several implications for policies from stakeholders and the government which aims to prepare aspects of facilities and human resources in facing educational challenges that are closely related to the development of internet technology and integrate them into the learning process in Biology subject.

Key words: *UTAUT Model, Educational policy, Habits, ICT use ICT Application, Structural Equation Modeling (SEM)*

Penerbit
Program Studi Pendidikan Biologi
FKIP Universitas Jambi,
Jambi- Indonesia

ABSTRAK

Penelitian ini bertujuan untuk menguji pengaruh langsung model UTAUT, kebijakan pendidikan dan kebiasaan penggunaan informasi dan komunikasi (ICTuse). Dimensi tersebut dikembangkan dengan mengusulkan indikator penelitian yang berdampak parsial dan simultan. Dengan sampel sebanyak 251 guru mata pelajaran Biologi. Penelitian ini menggunakan Structural Equation Modeling (SEM) melalui pendekatan partial least square (PLS). Temuan dari penelitian ini mengungkapkan bahwa hubungan terkuat muncul antara ekspektasi kinerja dan niat perilaku sementara korelasi yang paling kuat adalah antara pengaruh sosial dan niat perilaku. Model ini fit dengan Standardized Root Mean Square Residual sebesar 0,060. Berdasarkan temuan penelitian, penelitian ini memberikan implikasi terhadap kebijakan/program yang bertujuan untuk mendorong guru mengadopsi pengajaran berbasis TIK. Dari perspektif manajerial dan kelembagaan, penelitian ini berimplikasi pada beberapa kebijakan dari pemangku kepentingan dan pemerintah yang bertujuan untuk mempersiapkan aspek fasilitas dan sumber daya manusia dalam menghadapi

tantangan pendidikan yang erat kaitannya dengan perkembangan teknologi internet dan mengintegrasikannya ke dalam proses pembelajaran. dalam mata pelajaran Biologi..

Kata kunci: *Model UTAUT, Kebijakan Pendidikan, Kebiasaan, Penggunaan TIK Aplikasi TIK, Structural Equation Modeling (SEM)*

INTRODUCTION

Indonesia is a sizable nation that has the capability of advancing into a more prosperous country by leveraging the significant value of ICT development in the education sector. This would better equip students for future endeavors. The government has implemented a range of initiatives that emphasize educational technology. However, these endeavors may lack practical application since new technologies are introduced frequently, without thoroughly considering users' attitudes towards ICT and comprehending the factors that influence their acceptance or rejection. Given these challenges, many studies have investigated the determinants that influence teachers' beliefs especially in Biology subjectabout ICT-based instructional (Bozorgkhou, 2015; Chauhan & Jaiswal, 2016; Garone et al., 2019; Teng et al., 2022; Wu & Lee, 2017). Nonetheless, there is insufficient in-depth investigation to validate the impact of Indonesian teachers integrating ICT-based teaching practices, particularly in the field of Biology. As a result, this study endeavors to develop a conceptual framework that outlines the effective use of ICT by Biology teachers in Indonesia.

This model was built based on the Unified Theory of Acceptance and Use of Technology (UTAUT) and will be specific to the context of Biology teaching. This research focuses on examining the practical outcomes of the UTAUT Model, educational policies, and habits on Biology teachers' use of ICT for teaching. The study's framework includes various dimensions that are measured by research indicators. These indicators are expected to have a significant and combined influence on the integration of ICT into Biology teaching. By proposing and evaluating a conceptual model, the study aims to provide insights into the factors that contribute to the adoption of ICT use practices. (1) Starting from a literature review on learning using ICT, this study proposes and tests a model that combines endogenous factors (teacher's psychological aspects) and exogenous factors (perceptions of the context in which teachers engage in classroom learning). (2) More specifically this research integrates the UTAUT model, educational policy and ICT Habits which are developed to become a determining model for the Implementation and Use of ICT in learning.

METHOD

This study used a survey research design (Andrade, 2020; Ball, 2019; Evans & Mathur, 2005; Rowan et al., 2001). A survey is a method used to gather information regarding people's knowledge, attitudes, and behaviors. It enables the collection of data to describe, compare, or explain various aspects of human behavior (Foulger et al., 2021; Geldsetzer, 2020). The research was conducted for teachers in teaching Biology. The method of collecting data in this study is an online questionnaire with the help of the GoogleForm (Aqsa & Kartini, 2015; Braun et al., 2020, 2021) . To conduct this study, a closed-ended questionnaire was utilized, offering respondents a selection of predetermined answer choices. The questions related to each construct were taken from validated instruments used in

previous studies. All quantitative items in the questionnaire were measured using a seven-point Likert scale, ranging from Strongly Disagree (1) to Strongly Agree (7), with intermediate options in between. To ensure that the questionnaire was appropriate for the study's purposes, it was carefully designed and reviewed.

The variables used in the study were derived from earlier research studies (Al-Adwan et al., 2022; Escobar-Rodríguez et al., 2014; Raza et al., 2021; Suki & Suki, 2017) The data analysis used is a path analysis test with a partial least squares structural equation model (PLS-SEM). SEM is a sophisticated analytical technique for assessing connections between constructs through a series of causality conjectures (J. F. Hair et al., 2020; Matthews, 2017; Sohaib et al., 2020). This method is based on confirmatory factor analysis and is one of the most popular methods for assessing hypotheses in a research context (Habibi, A. Yusop, F, D. Razak, 2019; Yusop et al., 2021). PLS-SEM is a component-based SEM method that is used extensively in assessing connections between independent and dependent constructs in recent research (Basco et al., 2021; Hair Jr. et al., 2017; Mustofa et al., 2022). PLS-SEM was conducted to assess the hypotheses that were developed. The measurement model and structural model assessment are two stages in PLS-SEM.

RESULTS

Measurement Models The purpose of assessing the research model proposed in this study is to ensure the reliability of the survey instrument and ensure that the survey items can measure the factors they wish to measure. Testing for convergent validity and discriminant validity is a key process in evaluating measurement models. Convergent validity achieved to the ICT of each item was significantly associated with the expected theoretical factor, whereas discriminant validity obtained to the ICT of each item was weakly associated with all other factors excluding theoretically related factors (Baek et al., 2003; Campbell & Fiske, 1959; Kopcha et al., 2014). Convergent Validity Convergent validity is believed to be a key process in measuring survey research instruments. Convergent validity refers to the extent to which a measurement item of the exact factor in the context of the model is assumed to be comparable to other measurement items of the same factor. Convergent validity is a significant relationship between alternative measures of certain factors.

The correlation between the construct and the observed variables was evaluated with convergent validity (Schumacker and Lomax, 2004). The factor loading index (factor loading) is used to assess convergent validity, the validity achieved to the if loading value is significant. Each item that contains a factor must exceed the value of 0.50 to achieve convergent validity. Convergent validity is also determined by the Average Variance Extracted (AVE) and composite reliability (CR) values. To obtain convergent validity the AVE value must be > 0.50, and CR must be > 0.7 (Hair et al., 2017) or exceed 0.80. The PLS technique was employed to evaluate the convergent validity of the study. The results of this analysis are presented in the table below, using the PLS-SEM Algorithm format. The table outlines the final results obtained from the measurement model of the variables. The evaluation of the reflective indicators revealed that some loading factors fell below the recommended thresholds or values. However, upon conducting the PLS-SEM process, it was observed that most of the indicators had achieved the recommended value of >0.708. (Hair et al. 2020). The loading factor for all items exceeds the value of 0.708.

Table 1. Reliability and validity

Construct	Item	Load	α	rho_A	CR	AVE
Supporting condition	SC2	0.806	0.699	0.699	0.833	0.625
	SC3	0.821				
	SC5	0.744				
Performance expectancy	PE1	0.896	0.873	0.878	0.922	0.798
	PE2	0.913				
	PE3	0.870				
Habits	H1	0.709	0.800	0.803	0.870	0.627
	H2	0.844				
	H3	0.796				
	H4	0.811				
Educational policy	EP1	0.908	0.520	0.611	0.796	0.665
	EP2	0.710				
Behavioral intention	BI1	0.907	0.714	0.736	0.874	0.776
	BI2	0.854				
ICTuse	USE1	0.805	0.830	0.840	0.880	0.594
	USE2	0.795				
	USE3	0.781				
	USE4	0.770				
Sosial influence	SI1	0.828	0.797	0.799	0.868	0.621
	SI2	0.771				
	SI3	0.752				
	SI4	0.737				
	SI5	0.763				
Perceived ease of usen	PEU1	0.814	0.831	0.844	0.887	0.663
	PEU2	0.844				
	PEU3	0.849				
	PEU5	0.746				

The PLS SEM analysis yielded satisfactory results for the discriminant validity threshold, as indicated by the smaller Heterotrait-Monotrait Ratio (HTMT) value, which was found to be less than 0.90, as recommended by Hair et al. (2017). The table above shows that all HTMT values were lower than 0.90. Additionally, the PLS-algorithm process for HTMT indicated that the confidence interval was <1. This confirmed that all HTMT values were significantly different from 1. Overall, the results of the measurement model for both convergent and discriminant validity revealed satisfactory values.

Table 2. HTMT

	SC	PE	H	EP	BI	SI	USE	PEU
Supporting condition								
Performance expectancy	0.695							
Habits	0.666	0.588						
Educational policy	0.543	0.409	0.438					
Behavioural Intention	0.623	0.718	0.761	0.484				
Sosial influence	0.819	0.784	0.652	0.457	0.648			
ICTuse	0.706	0.593	0.659	0.457	0.647	0.624		
Perceived ease of usen	0.820	0.583	0.707	0.490	0.639	0.647	0.674	

Evaluation of Structural Models The structural model represents the relationship between exogenous and endogenous variables which are formulated in a hypothetical model (Kline, 2015). The purpose of this analysis is to confirm or reject the proposed hypothesis. Structural model involves a series of relationships between factors that the model hypothesizes. The structural model establishes direct and indirect relationships between factors and explores the amount of variance (explained/unexplained) in the model. Path Coefficients The path coefficient measurement highlights the strength of the relationship between the two constructs in the structural model (Lin & Hsieh, 2010). In this section a bootstrapping technique with 5000 repeated samples is performed to achieve a beta (β), t value and confirm the significance of the hypothesis as recommended (Hair et al., 2013; Hair et al., 2011).

The bootstrapping results are shown below. In this study, the bootstrapping steps are used to test the level of significance of the path of each construct. This is done by taking 5000 new samples. In bootstrapping, random observations from the original data set are used to make smaller sets of data (with replacement). The PLS path model is then estimated using the subsamples. This is done over and over until a lot of random subsamples have been made (usually about 5000). To get the standard error for the PLS-SEM results, the sub-sample bootstrap is used to make an estimate. Using this data, t-values, p-values, and confidence intervals are used to figure out how important the PLS-SEM results are (Table 3).

Table 3. Path Coefficients result and hypotheses testing.

H	Jalur	β	T-Value	P-Values	F^2	Remarks
H1	Performance expectancy -> Behavioural Intention	0.347	7.735	0.000	0.104	Confirmed
H2	Perceived ease of usen -> Behavioural Intention	0.235	5.570	0.000	0.061	Confirmed
H3	Sosial influence -> Behavioural Intention	0.121	2.784	0.006	0.012	Confirmed
H4	Educational policy -> v	0.091	3.174	0.002	0.012	Confirmed
H5	Supporting condition -> ICTuse	0.304	7.300	0.000	0.111	Confirmed
H6	Habits -> ICTuse	0.254	5.699	0.000	0.064	Confirmed
H7	Behavioural Intention -> ICTuse	0.217	5.264	0.000	0.050	Confirmed

Model Fit

The objective of the Goodness of Fit (GoF) test is to evaluate research models by analyzing the performance of comprehensive models that include both level measurement and structural models (Harris, 2008; Hu & Bentler, 1998; Schuberth et al., 2022). The saturated model must get an SRMR value of less than 0.08 to pass this test. The Normed Fit Index (NFI) can also be used to figure out how accurate a PLS model is. If the NFI is close to 1, the model is a good fit. In this study, the saturated SRMR model gave a result of 0.064, which proved that the model was a good fit. The assessment threshold was met by the NFI value of 0.607. RMS theta should be used to evaluate PLS-SEM models that are based on common factors. But this is only true for composite models made with PLS-SEM. RMS theta values below 0.12 show that a model fits, while values above 0.12 show that the model doesn't fit (Dijkstra & Henseler, 2015; Schuberth et al., 2022). Following are the results of testing the fit model on the structural model (Table 4).

Table 4. Model Fit

	Saturated Model
SRMR	0.060
d_ULS	1.363
d_G	0.482
Chi-Square	2334.555
NFI	0.775
rms Theta	0.145

DISCUSSION The research findings of this study have important implications for policies and programs aimed at encouraging teachers to adopt ICT-based teaching in Biology. The study found that Performance Expectancy was the most significant construct in predicting teachers' intention to use ICT, with participants recognizing the benefits that can be gained through the use of these technologies. This highlights the need for policymakers and practitioners to focus on promoting the benefits and advantages of ICT-based instruction to teachers. It is crucial to highlight and demonstrate the benefits of using ICT in order to encourage teachers to accept and adopt these technologies. The finding that performance expectancy has a positive impact on teachers' behavioral intention to use ICT suggests that teachers are more likely to use ICT if they perceive it as easy to use and efficient in saving time for various tasks and activities. However, it is worth noting that the significance of performance expectancy may decline as teachers become more experienced in using ICT over time (Alalwan et al., 2018; Morosan & DeFranco, 2016; Zhou et al., 2010). These results show how important it is to make sure that all ICT devices and systems are easy to use. This is especially important for teachers, who have different levels of technical knowledge and experience with ICT. The fact that the findings about perceived ease of use are statistically important shows how important it is to make sure that teachers have good experiences while using ICT. This is because these kinds of things can affect coworkers, students, and other people. The Asia-Pacific Ministerial Forum on ICT in Education 2017 also talked about how important it is to create learning spaces and communities that help teachers and make it easy for them to share new ideas (Al-Saedi et al., 2020; Magsamen-Conrad et al., 2015). From the perspective of the path coefficient with Supporting conditions and Habits, it is a newly added construct variable, which has a positive and significant effect. The impact of Habits on the real implementation of ICT-based instruction among teachers suggests that the stronger the belief of teachers in their intention to use ICT for instruction, the more likely they are to use it. Previous studies have identified intended use as a factor that influences the actual use of technology (Hsu & Chang, 2013; López-Bonilla & López-Bonilla, 2017; Tamir, 1988). This finding aligns with previous research results, indicating that as teachers' intention to use ICT for classroom teaching increases, their level of supporting conditions is also expected to increase. The study has demonstrated that the inclusion of the Teacher ICT Habits construct in the UTAUT model has a significant impact on the adoption of ICT-based instruction by teachers. This suggests that teachers' past experiences with ICT and their comfort level with its use can positively influence their adoption of ICT in the classroom. Based on these findings, it is recommended that policy makers and educators provide opportunities for teachers to gain familiarity and training in the use of ICT, which can facilitate their adoption of it for teaching. For example, the Next Generation of Teachers (NET) project could be a useful initiative for teacher

education institutions in the Asia-Pacific region to prepare teachers to effectively incorporate technology in their teaching practices (Habibi et al., 2022). In addition, promoting favorable conditions and influential factors for teachers to adopt ICT-based instruction implies that the successful adoption of ICT-based instruction depends on the availability of essential tools, school policies, support from the school, and a strong commitment to ICT-based instruction. This perspective is consistent with the regional strategies recommended by UNESCO in 2018 for improving basic education systems in the Asia-Pacific region, which emphasizes the need to address gaps in school ICT infrastructure and the uneven distribution of internet usage across sub-regions and within them (Al-Adwan et al., 2022; Escobar-Rodríguez et al., 2014; Yueh et al., 2015) CONCLUSION This study extends the UTAUT model to explain the adoption of ICT-based instruction in Biology teaching and can be useful for decision-makers in developing strategies for implementing ICT-based instruction successfully. The addition of two new constructs, namely educational policy and ICT Habits can be used as a framework for researchers to explore teacher acceptance and use of ICT-based instruction in their educational contexts. However, there are limitations associated with using online questionnaires, and further empirical research is needed to gain more insights into teacher behavior and the use of ICT-based instruction. Future studies should refine the proposed model by adding appropriate constructs and considering regional contexts, including rural and cultural areas, to generalize the findings and discussions presented in this study. Multi-group analysis using regional context can also have implications for proposing additional policies in the future. Overall, this study provides valuable insights into the factors that influence teacher adoption of ICT-based instruction and highlights the importance of considering contextual factors in educational technology research.

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