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The Structural Equation Model of actual use of Cloud Learning for Higher Education students in the 21st century

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Abstract

The purposes of this research were to 1) develop the structural equation model of the actual use of cloud learning for higher education students in the 21st century (SEMAC), 2) investigate the validity of the SEMAC, and 3) study the effects of the SEMAC. This study was a correlation research. The research sample consisted of 1,170 undergraduate students, randomly selected using multi-staging, from 18 universities in Thailand. The research instruments were questionnaires about system quality, convenience, social interaction, perceived ease of use, perceived usefulness, and actual use. Data analyses were descriptive statistics and the analysis for model validation used LISREL 9.2. The study found that the validation of the structural equation model indicating actual use of cloud learning showed that the model fit to the empirical data ($\chi 2$ = 34.659 df = 23 p = .056 GFI = .989 AGFI = .974 RMR = .006). The variables in the structural equation model could explain 62.4 of the variance in actual use. The research results can be used as data to improve the actual use of cloud learning.

KEYWORDS: Cloud Learning, TAM, Technology Acceptance Model, Structural Equation Model.

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1. Introduction

Cloud technology is one of the revolutions of 21st century computer operations (Yamin, 2019). It supports industrial, social (Buyya et al., 2012), business, medical, and educational (The Economist Intelligence Unit Limited 2016; Jaleel, 2018) operations. Moreover, cloud technology is a problem-solving tool for the basis of communications technology in various organizations. This is because it helps to reduce the network costs of the company's investment in both software and hardware. It also helps to reduce the duration of operations and resource management that is essential and allows cooperation in real-time (Sathaporn, 2014).

Based on these innovations, the Thai government realized the importance of cloud technology, and decided to plan for its support. This encompasses projects about information technology and the country's communications, in order to improve technology, and the rapid deployment of a national communications infrastructure that is extensive, expandable, and able to serve high speed internet efficiently, everywhere at any time (Ministry of Information and Communication Technology, 2016). To support the execution of cloud

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technology and communication in both the public and private sectors (especially, the education sector), the Thai government created a development policy to improve the economy and society called 'Digital Thailand' from 2559 B.E. to 2561 B.E. This provided access to digital technology in Thailand, which was aimed at helping to improve the Thai people's potential for creativity and provide technology advantages. Thus, this helped the country to develop a basic infrastructure of innovation, information, and human resources, that enabled the country's economy and society to consistently, prosperously, and sustainably improve. This is related to the third strategy, which is to create equality among Thai citizens via the use of digital technology. Hence, there is an increased the opportunity for all Thai citizens to receive a standard education anywhere and anytime (Ministry of Information and Communication Technology, 2016).

By the execution of the above-mentioned policy, the Office of the Higher Education Commission (OHEC) had realized how important it was to rapidly improve education. Therefore, it decided to construct the 12th Higher Education Development Plan: 2017 – 2021. This created a basic infrastructure policy for higher education that required information technology and communication tools as well as development in classrooms (Office of the Higher Education Commission, 2016), especially cloud learning, to satisfy the standards of 21st century lesson design. This development plan urges the higher education institutes to prepare for the essential learning system factors in different fields, such as the learning system environment, cloud computing or cloud services, lecturers, learners, and system administration (Chanin et al., 2020). Moreover, as the COVID-19 pandemic has had a severe impact on people globally, and disrupted the traditional methods of learning and teaching, cloud learning has been implemented in several institutes as a tool to prevent disruption to learning and teaching. This tool also enables both learners and lecturers to access classes and lessons from their home at any time (WP, 2020).

As mentioned above, the researcher's objective for studying the structural equation model of the actual use of cloud learning for higher education students in the 21st century (SEMAC) was to use statistical techniques to analyse causal relationships. The findings obtained identify both the cause and variables. Both direct and indirect influencing paths of variables could be shown. In addition, the correctness or validity of the theory was also able to be investigated.

2. Research Questions

The research questions that guided the investigation of the actual use of cloud learning for higher education students in the 21st century were the following:

1. What is a concept framework of the structural equation model of the actual use of cloud learning for higher education students in the 21st century?
2. How relevant is the structural equation model of the actual use of cloud learning for higher education students in the 21st century towards empirical data?
3. How much impact can the structural equation model of the actual use of cloud learning for higher education students in the 21st century have?

3. Research Objectives

The purposes of this study were:

1. To develop a structural equation model of the actual use of cloud learning for higher education students in the 21st century.
2. To investigate the validity of the structural equation model of the actual use of cloud learning for higher education students in the 21st century.
3. To study the effects of the structural equation model of the actual use of cloud learning for higher education students in the 21st century.

4. Concept Framework

This section describes the analysis of the SEMAC model results. The researcher studied, synthesized, and designed these concepts from nine related subject resources, including official public research and journals supporting the research as shown in Figure 1. These were used to scope out the positive direct effect of the concept framework as follows.

System quality has a positive direct effect on perceived ease of use, and perceived usefulness (Chang & Chiang, 2012; Alshibly, 2014; Calisir et al., 2014). System quality has a positive direct effect on actual use of cloud learning (Alshibly, 2014; Alzu'Bi & Hassan, 2016). Convenience has a positive direct effect on perceived ease of use, and perceived usefulness (Chang et al., 2013; Hsu & Chang, 2013; Yung Ming Cheng, 2015). Convenience has a positive direct effect on actual use of cloud learning (Chang et al., 2013; Yung Ming Cheng, 2015). Social interaction has a positive direct effect on perceived ease of use, and perceived usefulness (Chang & Chiang, 2012; Elkaseh et al., 2016). Social interaction has a positive direct effect on actual use of cloud learning (Essam & Al-Ammary, 2013). Perceived ease of use has a positive direct effect on perceived usefulness (Hsu & Chang, 2013; Calisir et al., 2014). Perceived ease of use has a positive direct effect on actual use of cloud learning (Hsu & Chang, 2013). Perceived usefulness has a positive direct effect on actual use of cloud learning (Chang & Chiang, 2012; Hsu & Chang, 2013). Furthermore, the findings showed that system quality, convenience, social interaction, perceived ease of use, and perceived usefulness have

positive direct effects on actual use of cloud learning. Hence, these five factors supported cloud learning to be more effective and efficient.

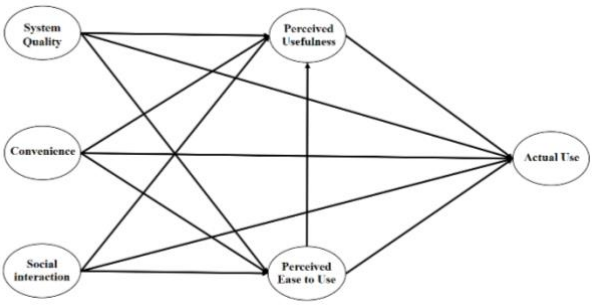

Figure 1 - Conceptual Framework.

5. Research Hypotheses

According to the study of the SEMAC, five hypotheses were determined by the researcher as follows:

1. System quality has a positive direct effect on actual use and an indirect effect via perceived ease of use and perceived usefulness.
2. Convenience has a positive direct effect on actual use and an indirect effect via perceived ease of use and perceived usefulness.
3. Social interaction has a positive direct effect on actual use and an indirect effect via perceived ease of use and perceived usefulness.
4. Perceived ease of use has a positive direct effect on actual use and an indirect effect via perceived usefulness.
5. Perceived usefulness has a positive direct effect on actual use.

6. Research Methodology

6.1. Population and Samples

The population of this study were undergraduate students who had used cloud learning from universities that are under the Office of the Higher Education Commission. The sample comprised 1,170 undergraduate students from eighteen universities selected by Multistage Random Sampling. During the first phase, the regions were selected by Cluster Random Sampling, and nine Higher Education Development Networks of the Office of the Higher Education Commission were selected. In the second phase, two universities of each Higher Education Development Network were selected by Simple Random Sampling. For the third phase, the sample of undergraduate students who had used cloud learning at each university consisted of 65 students selected by Simple Random Sampling.

6.2. Variables of research

There were six variables for this study. They can be classified into three types: 1. Exogenous latent variable, 2. Mediator latent variable, and 3. Endogenous latent variable.

6.2.1. The exogenous latent variable consisted of three indicator variables as follows:

6.2.1.1 *System Quality* (SYS): System quality refers to the efficiency of information technology in both the technical and design fields (DeLone and McLean, 1992). Thus, it was necessary to test the operation and performance of the system (Urbach and Müller, 2012). It was necessary to examine the research studies of system quality latent variables including the following three indicator variables: 1) Availability (SYS1), 2) Stable (SYS 2), and 3) Quick Response (SYS 3).

6.2.1.2 *Convenience* (CON): Convenience is a step that reduces complexity. Nowadays, convenience is created by the use of tools or technology that helps people to save time and energy. Technological innovations and tools enable services and other duties to become more efficient. This concept is relevant, and it depends on each case (Wikipedia, 2019). The research studies in convenience cover sub-variables in two dimensions including: 1) Time (CON1) and 2) Place (CON 2).

6.2.1.3. *Social Interaction* (SOC):

Social interaction is the social action of two or more people that represents the relationship between them, such as talking. Those who participate in social interactions can be family members, friends, partners, and others (Wikipedia, 2019; Rummel, 1976). The research studies of social interaction cover sub-variables in two dimensions including: 1) Social Media (SOC1) and 2) People (SOC2).

6.2.2. The mediator latent variables of this study were perceived usefulness and perceived ease of use.

6.2.2.1 *Perceived Usefulness* (PU): Perceived usefulness is an important variable that represents technology acceptance, especially innovative technology (Chtourou and Souiden, 2010). It shows the level of acceptance of using technology to improve efficiency and repair the operation (Davis, 1989; Davis et al., 1989).

6.2.2.2 *Perceived Ease to Use* (PEOU): Perceived ease of use is an explanation of the user's perception of the effort necessary to use or implement the system, and the scope of their beliefs about the ease of use of technology (Davis et al., 1989).

The two main variables in the Technology Acceptance Model (TAM) theory are perceived usefulness and perceived ease of use.

6.2.3. The endogenous latent variable was actual *use* (USE): For the core causal factor of this study, it is the 'actual use' that is stated to be the limitations of the user in the system (DeLone & McLean, 1992). This includes responses to the user and parts of the system in terms of viewing, searching, and other types of responses (Abbas

& Mahmonir, 2013). Furthermore, actual use is also a dependent variable of two theories: 1. The Technology Acceptance Model theory (Davis, 1985), and 2. The IS Success Model theory (DeLone & McLean, 1992). In this study, the research about cloud learning instructions, which is a learning tool, included co-operation, project creation, presentation, co-learning, and information management (Heng et al., 2016).

6.3. Data Collection and Analysis

The instrument used a five-level rating scale measuring the following six variables: system quality, convenience, social interaction, perceived ease of use, perceived usefulness, and actual use. The researcher developed the questionnaire by using interpretations from questionnaires developed in other countries and adapting, modifying, and creating additional statements as appropriate for the context of Thailand for each of the six parts. The statements from the questionnaire were investigated for item-objective congruence (IOC). This found that the statements had IOC values from .82 to .91. The researcher tested the questionnaire with a pilot of 40 samples to investigate its reliability using Cronbach's Alpha coefficient. This found that the reliability values were between .819 and .931. These numbers verified that it was a good quality questionnaire. Confirmatory factor analysis of the six variables was performed by using LISREL 9.2 and found that all six variables had construct validity.

Data was collected by the researcher after seeking permission from the lecturers at each university. They were followed up with reminders in order to maximize the return rate and an appointment was made with each recipient for the researcher to collect the online questionnaire in person. There were 1,170 questionnaires issued with rate of 100% of returned questionnaires. The validity of the causal model was investigated by the researcher based on hypotheses one to five using LISREL 9.2.

7. Result

The results of the study consist of two parts as follows: 1) The result of relationships between observable variables, and 2) The result of the structural equation model.

The details are as follows:

1. The result of relationships between observable variables. The researcher analysed the data of the relationships between ten observable variables and the findings are shown in Table 1.

The findings of the analysis of observed variables investigating the relationships between the nine observed independent variables and one observed dependent variable showed that the relationship between system quality (SYS) variables and actual use (USE) variables ranged between .472 and .545. The second

Variable	SYS 1	SYS 2	SYS 3	CON1	CON2	SOC1	SOC2	PEOU	PU	USE
SYS1	1.000									
SYS2	.719**	1.000								
SYS3	.574**	.633**	1.000							
CON1	.555**	.479**	.576**	1.000						
CON2	.556**	.498**	.593**	.757**	1.000					
SOC1	.449**	.499**	.436**	.489**	.523**	1.000				
SOC2	.471**	.414**	.489**	.481**	.527**	.761**	1.000			
PEOU	.424**	.354**	.433**	.409**	.396**	.461**	.516**	1.000		
PU	.456**	.418**	.459**	.477**	.460**	.619**	.681**	.733**	1.000	
USE	.545**	.472**	.522**	.567**	.608**	.540**	.590**	.626**	.670**	1.000
Mean	4.091	4.107	4.166	4.004	4.030	4.183	4.107	4.209	4.242	4.153
S.D.	.521	.576	.564	.552	.556	.514	.497	.588	.508	.526

Note ** p<.01

Table 1 - The mean, standard deviation, and matrix of correlation coefficient between the observed variables using in the research study (N = 1,170).

order was the relationships between convenience (CON) variables and actual use (USE) variables, which ranged from .567 to .608. The relationship of social interaction (SOC) variables with actual use (USE) variables ranged from .540 to .590. The relationship of perceived ease of use (PEOU) variables with actual use (USE) variables was .626, and the relationship of perceived usefulness (PU) variables with actual use (USE) variables was .670. The analysis findings of the relationships between a total of ten observed variables showed that the reliability coefficient of all nine observed variables, or a total of 36 pairs, ranged for the correlation coefficient from .354 to .761 which was different from zero at the .05 significance level, and therefore showed no problem with multi-collinearity.

2. The findings of the investigation of SEMAC consisted of exogenous variables, which comprised three variables including system quality (SYS), convenience (CON), and social interaction (SOC), and mediator variables including two variables: perceived ease of use (PEOU) and perceived usefulness (PU). The endogenous variable of actual use (USE) found that the Chi-square = 34.659, df= 23, GFI = .989, AGFI = .947, and RMR = 005. This showed that the structural equation model developed by the researcher was in harmony with the empirical data. The variables in the structural equation model could explain the variance of actual use (USE) for 62.4 % as shown in Figure 2 and Table 2.

The size of the effect of each of the five independent variables on actual use can be divided into two groups as follows: 1. the variable showed direct effects and indirect effects, and 2. the variable showed only direct effects, as shown in Figure 2.

2.1 The variables which represented both direct and indirect effects were convenience (CON), system quality (SYS), perceived ease of use (PEOU), and social interaction (SOC) on the actual use. The variables' total effective sizes were .191, .336, .312, and .304, respectively. System quality (SYS), convenience (CON), and perceived ease of use (PEOU) had a direct impact on actual use (USE) as well as an indirect impact. Its direct impact sizes were .116, .323 and .224 and indirect impact sizes were .075, .013 and .080, respectively. This means that when the student uses cloud learning the system quality provides convenience and perceived ease of use, which results in the student wanting to pursue the actual use of cloud learning (USE) more (direct impact > indirect impact). Social interaction had an indirect effect on actual use rather than a direct effect. Its indirect impact size was .206 and direct impact size was .106. It can be concluded that when the student engages in social interaction, he or she will pursue the actual use of cloud learning (USE) more often (indirect impact > direct impact).

2.2 The variable showed a direct effect on actual use. Perceived Usefulness (PU) had a direct effect size of .181. This indicates that when a student has acknowledged perceived usefulness, the actual use of cloud learning (USE) will increase continuously.

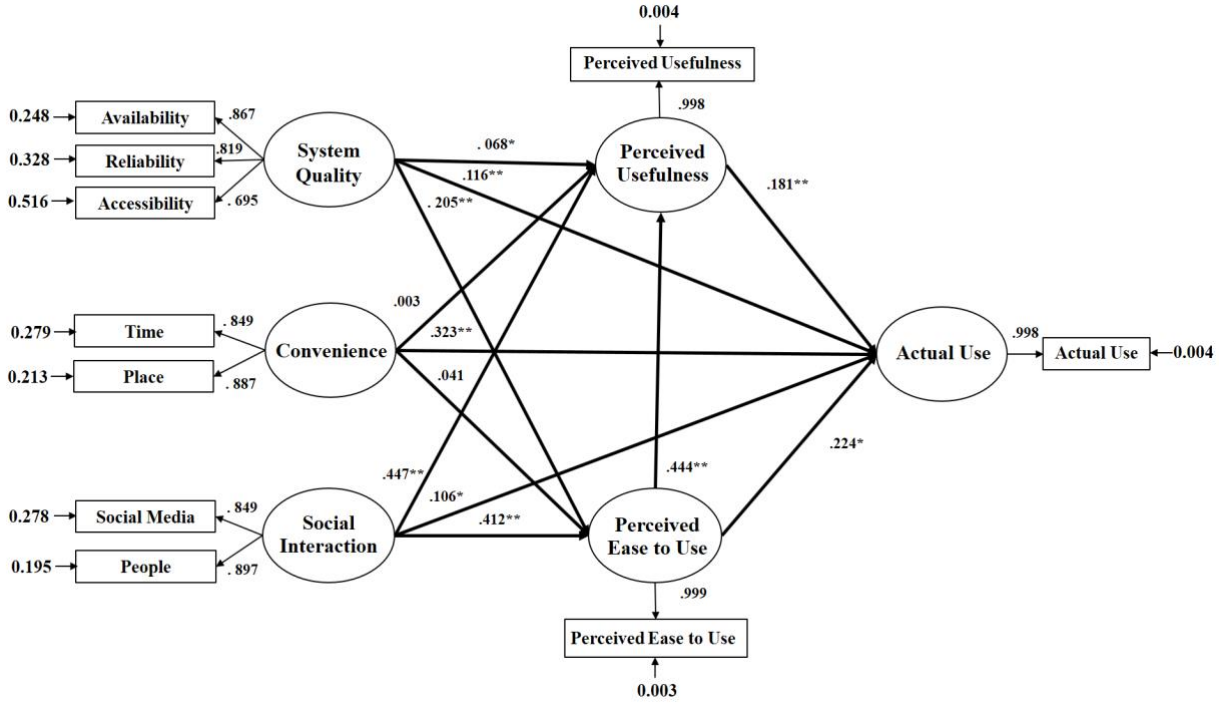

Figure 2 - The structural equation model of actual use of cloud learning for Higher Education Students in the in 21st century.

Dependent Variable		PEOU			PU			USE		
Independent Variable	**Statistics**	**TE**	**IE**	**DE**	**TE**	**IE**	**DE**	**TE**	**IE**	**DE**
SYS	CS	.205**	-	.205**	.159**	.091*	.068*	.191**	.075**	.116**
	SE	.044	-	.044	.037	.020	.031	.038	.016	.034
CON	CS	.041	-	.041	.021	.018	.003	.336**	.013	.323**
	SE	.046	-	.046	.039	.021	.032	.040	.016	.036
SOC	CS	.412**	-	.412**	.630**	.183**	.447**	.312**	.206***	.106**
	SE	.040	-	.040	.035	.019	.031	.034	.024	.037
PEOU	CS	-	-	-	.444**	-	.444**	.034**	.080**	.224**
	SE	-	-	-	.022	-	.022	.024	.016	.028
PU	CS	-	-	-	-	-	-	.081**	-	.181**
	SE	-	-	-	-	-	-	.035	-	.035

Statistic χ^2 = 34.659 df = 23 p = .056 GFI = .989 AGFI = .974 RMR = .006

Variable Reliability	**SYS1**	**SYS2**	**SYS3**	**CON1**	**CON2**
	.271	.321	.318	.305	.309
Variable Reliability	**SOC1**	**SOC2**	**PEOU**	**PU**	**USE**
	.264	.247	.346	.258	.277
The Structural Equation Model		**PEOU**	**PU**	**USE**	
R2		.353	.697	.624	

Note: *p < .05, **p < .01, TE = total effect, IE = Indirect Effect, DE = Direct Effect, CS = Completely Standardize Solution, SE = standard error

Table 2 - The analysis findings of validity of actual use

8. Conclusion and Discussions

According to the research implemented in respect of the SEMAC, the researcher found three major issues to discuss as follows.

1. The SEMAC had empirical validity. The study found that the Chi-square = 34.659, df= 23, GFI = .989, AGFI = .947, and RMR = 0.0006. This showed that variables in the structural equation model could explain the variance of actual use (USE) for 62.4% of cases, which is greater than the required criterion (60%). Hence, the SEMAC that the researcher has developed is considered to be a suitable model because causal variables of system quality (SYS), convenience (CON), and social interaction (SOC) were present in the study. The mediator variables were perceived ease of use (PEOU) and perceived usefulness (PU). This can explain actual use. However, there are other causal variables that the researcher did not consider using in this study such as digital literacy (Mac Callum et al., 2014), self-efficacy (Bagci & Celik, 2018), online course design (Chinyamurindi et al., 2017), and perceived risk (Tripathi, 2018). These influence the actual use of cloud learning, which helps to provide further explanation of the variance of actual use of cloud learning systems.

2. To the results of this research, system quality had a positive direct effect as well as an indirect effect on actual use at the significance level of .05. This means that higher education institutes have to improve their systems to be more effective. This is proposed in the 12th Higher Education Development Plan 2017 – 2021, which states that there must be a structural improvement of information technology and communication technology to support their implementation as learning tools (Office of the Higher Education Commission, 2016), in order to properly follow the government policy. The Ministry of Information and Communication Technology of Thailand (Ministry of Digital Economy and Society) has created the Thailand Digital Economy and Society Development Plan: Digital Thailand 2016 – 2037 to enable the country to utilize and improve creativity with the efficient implementation of digital technology in order to develop basic infrastructure, innovation, information, human resources, and other resources. Hence, this aims to drive the Thai economy and society to become more stable, prosperous, and sustainable (Ministry of Information and Communication Technology of Thailand, 2016).

Convenience had a positive direct effect on actual use at the significance value of .05. This shows that when the

student obtains 'convenience' in online learning through cloud learning, he or she may select times and places to study as he or she prefers. Thus, it highlights what learning in the 21st century is becoming (Mooc-Maker, 2016).

Social interaction had a positive direct effect and an indirect effect on actual use at the significance value of .05. This is because society in the present digital period utilizes digital technology in every area or sector, including learning (Grand-Clement, 2017). Therefore, social interaction in the cloud is considered to be an important factor for employment and livelihoods, because cloud technology is a tool that helps people to communicate and connect in groups easily, especially for learning and teaching (Jenny, 2017).

Perceived ease of use had a positive direct effect and indirect effect on actual use at the significance level of .05, whereas perceived usefulness had a positive direct effect on actual use at the significance value of .05. These two variables are parts of the Technology Acceptance Model (TAM) theory that discusses and explains the acceptance factors or the actual use of information technology (Bertrand and Bouchard, 2008; Park, 2009). The results mentioned state that when the student recognizes different operational functions, he or she will perceive the ease of use. Thus, the use of the cloud learning system increases.

3. The research tool used in this study also showed an IOC value for every question with a higher significance value than the standard (greater than or equal to .5). Also, when the researcher used the 'Try Out' tool to test the quality of the tools to analyse reliability using the Cronbach's Alpha coefficient, it was found that the reliability of the questionnaire for every latent variable was at a high level. After analysing the data using Lisrel 9.2, the results indicated that only the observed variable of system quality (SYS), which was Stable (SYS2), had a value of .574 (lower than the standard of .7). Thus, if other researchers would like to use this questionnaire, they should edit the questions beforehand in order to correct this problem.

9. The expected usefulness

1. For academic usefulness, the findings show the value of the SEMAC.
2. For practical usefulness, the findings are useful for higher education institutes to prepare for the information technology infrastructure system.
3. For policy usefulness, the findings of this study are useful for higher education institutes, and their presidents may use this study as the basis of policy planning for information technology development in learning and teaching.

10. Recommendations for Policy

In this section, the researcher would like to make the following suggestions for policy development:

1. The Ministry of Higher Education, Science, Research and Innovation must encourage and support higher education institutions to implement information technology as a part of lectures to reduce the gap in literacy and education approaches.
2. Higher educational institutions should prepare basic knowledge and lessons in information technology to support cloud learning (for example, wireless networks).
3. The Ministry of Education should construct a policy that implements technology in basic education and vocational education learning to provide basic knowledge for those who are interested in pursuing higher education. This also includes educating and training lecturers about information technology and how to use it as a teaching and learning tool.

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