Malaysian Journal of Mathematical Sciences 16(4): 749–769 (2022)
https://doi.org/10.47836/mjms.16.4.08

Malaysian Journal of Mathematical Sciences

Journal homepage: https://mjms.upm.edu.my

Migrating to Technology Integrated Classes to Promote Higher Order Thinking Skills among University Students: Perspectives from Mathematics Academicians

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Received: 17 June 2021
Accepted: 9 August 2022

Abstract

This study investigates factors that influence the use of information and communication technology (ICT) tools by academicians to promote higher order thinking skills (HOTS) among university mathematics students. The study adapted constructs such as performance expectancy, effort expectancy and facilitating conditions from the Unified Theory of Acceptance and Use of Technology. The study applied descriptive research design and used quantitative and qualitative approach in the form of questionnaire and interview to gather data from 86 academicians from three local public universities in Malaysia. The data were analysed in terms of descriptive analysis and content analysis. The result showed that the technology, instructor, student, learning material, task and organisational factors play important roles in promoting HOTS among students. The study contributed to expanding readers' understanding of the factors that influence the use of ICT tools by academicians to promote HOTS among university students.

Keywords: mathematics; university students; ICT; higher order thinking skills; academicians.

1 Introduction

Education 4.0 was shaped to fulfil the Industrial Revolution 4.0 (IR 4.0) requirement. Under Education 4.0, the educational experts (policy makers and educators) recognise the significant impact of a myriad of technological innovations on education. These experts unanimously agree that students need to be trained to be innovators and creators under Education 4.0 [34]. In other words, students should be filled with higher order thinking skills (HOTS) which enable them to think creatively and analytically to solve a given problem and produce new solutions. Educational experts believe that technological innovations such as mobile computing, cloud, social network and big data can create students with HOTS([34]; [59]).

In addition, employers in Malaysia have raised concerns about the quality of the graduates produced by the higher learning institutions in Malaysia. Some employers reported that local university graduates lack technical skills, problem-solving skills and communication skills [24]. Therefore, this study investigates the factors that contribute to the use of ICT tools by academicians to promote higher order thinking skills among university mathematics students.

HOTS refers to the thinking process beyond the memorisation of facts. HOTS involve multiple levels of intellectual process to produce a unique outcome with values [18]. It involves higher level thinking skills such as analysis, synthesis and evaluation ([28]; [8]). Ability to master HOTS enables a person to solve unexpected problems critically and creatively. Today, various technology tools are used in teaching and learning activities. These technology tools range from simple presentation tools to more advanced tools such as augmented reality. These tools internal and external features are believed to influence their use among academicians to promote HOTS among students [34]. For instance, the use of MOOCs in education assists academicians in conducting teaching and learning activities without much hindrance. The use of MOOCs by academicians is also believed to promote critical thinking among students as it encourages more collaboration, discussion and arguments among peers, instructors and other experts [19]. Besides, the use of ICT tools also assists the academicians in enhancing the spatial ability of students [36]. Spatial ability is the process of visualising a structure and manipulating it in our mind to enable us to see its form mentally from different views or perspectives [66]. This enhances the students' understanding and allows them to process a problem or situation critically. It will assist the students in making sound and appropriate decisions. For instance, [36] reported that the use of the virtual patient systems in the classroom by academicians enables the pharmacy students to understand real-life clinical scenarios and make suitable decisions for the encountered problems.

Several factors were identified as the important catalysts that encourage the use of ICT tools by academicians to induce HOTS among university graduates. These factors can be grouped into technology factor ([6]; [16]; [32]), instructor factor ([25]; [38]), student factor ([7]; [35]), learning materials and task factor ([7]; [13]) and organisational factor ([45]; [60]).

In this study, the technology factor consists of constructs such as perceived ease of use, perceived usefulness and perceived enjoyment. [42] reported that academicians adopt mobile technology if it is easy to use. [42] further added that if a technology product requires lesser general ICT skills, academicians are more motivated to use it. It is because academicians may feel in control when using it. Therefore, academicians will be more likely to feel less anxious about handling the technical error in the technology product ([63]; [42]). This will motivate the academicians to

integrate more ICT tools in teaching and learning activities and focus more on learning activities to promote HOTS among students. For instance, [64] stated that academicians with better developed computing skills and knowledgeable in handling computer programmes are able to find ways to promote HOTS among students in technology-integrated classes. Therefore, in this study, perceived ease of use is considered one of the important criteria that can determine the adoption of ICT tools by academicians to promote HOTS among students.

Meanwhile, the perceived usefulness of ICT product also influences academicians to adopt ICT tools to promote HOTS among students. For instance, [58] stated that the use of ICT tools by academicians could promote HOTS among students efficiently as it can provide a promising platform for the application of constructivist principles in the teaching and learning activities. Furthermore, ICT tools assist in producing good learning outcomes ([5]; [4]), increase engagement levels [55] and enhance students' communication and collaboration rate, and thus directly play an important role in promoting HOTS. Therefore, it is expected that the benefits obtained through the use of ICT tools in teaching and learning activities will affect academicians' decision to adopt ICT tools to promote HOTS among students.

Perceived enjoyment is defined as the degree to which the task completed by using ICT tools delivers enjoyment to the users [22]. [37] and [67] stated that if an individual shows a positive perception of his ability to use ICT tools, this perception will encourage intrinsic motivation that leads to enjoyment. This enjoyment can increase academicians' engagement with the ICT tools, leading to the integration of more advanced ICT tools in the teaching and learning activities. This can assist the academicians in promoting HOTS among students. Therefore, in this study, perceived enjoyment is considered as one of the important criteria that can determine the adoption of ICT tools by academicians to promote HOTS among students.

Instructor factors also play an important role in promoting HOTS among students in the Technology Enhanced Learning (TEL) environment. For instance, instructor's attitude towards the technology can influence the promotion of HOTS among the students. A positive attitude would assist the instructors in setting the learning goals and plan the teaching approach and learning process adequately. This later will help the academicians to situate the technology meaningfully within their teaching [19]. This assists the students in using the technology more often to support their learning activities. [41] and [53] pointed out that instructors' positive attitude towards the integration of technology tools in active learning promotes students' HOTS accordingly. Besides, instructors' self-efficacy also influences the promotion of HOTS among students in the TEL environment. Self-efficacy affects choices of whether to perform a task and the determination is shown in completing it [51]. Thus, instructors' self-efficacy determines the use of ICT tools in their classes to promote HOTS among students effectively. Besides, the instructors' competence, that is, the skills and knowledge in operating the integrated technology, enables them to use the technology without anxiety and fear, which can lead to the promotion of HOTS [3]. Past studies proved that there is a strong correlation between ICT competency of academicians and the use of ICT tools for academic activities[64]. It is important to note that the negative attitude of an instructor, low self-efficacy and incompetent use of ICT tools by instructors inhibit the adoption of ICT tools among them and subsequently affect the adoption of ICT. Therefore, this will directly influence the promotion of HOTS among students in the TEL environment.

It is important to highlight that, in order to reap the benefit in the TEL environment, both academicians and students should use ICT tools. Therefore, the student factor also significantly

influences the promotion of HOTS in the TEL environment. [57] reported that students' attitudes towards technology affect the enhancement of HOTS. Past study regarding attitude towards technology showed that technology assisted the students to engage in active learning. In addition to that, attitude towards technology can impact students' engagement in learning, which can influence their learning approach and learning output that can lead to the promotion of HOTS ([56]; [52]). The students' self-efficacy also influences the use of ICT tools for their learning activities. Higher students' self-efficacy motivates them to use technology confidently in their learning activities [17], and thus can assist in the promotion of HOTS. Besides, technology competence also influences the promotion of HOTS among the students [31]. The skill needed to operate the technology increases the intrinsic motivation of the students and reduces their anxiety level ([39]; [33]). Therefore, the students can pay more attention to the learning process that can promote HOTS.

Approaches to learning are one of the prominent factors that are believed to highly influence the promotion of HOTS in the TEL environment. The deep vs. surface approach is the broadly accepted learning approach that divides the learning approach from the surface to a deep level. According to [26], in surface learning, students normally learn what is required to pass the examination and satisfy the minimum standards. They just memorise the content. Meanwhile, in a deep approach, students engage in learning content to achieve meaningful learning. They also apply critical analysis to understand the content. [56] and [15] reported that those students who adopt a deep learning approach in the TEL environment engage more in HOTS activities. It can be concluded that students' attitudes towards ICT use, self-efficacy, competent ICT use and learning approaches affect ICT tool adoption among students in learning activities to promote HOTS. Therefore, it is important to identify the effect of students' factors in promoting HOTS in the TEL environment.

In a TEL environment, instructors should prepare appropriate learning tasks and questions that enable the students to make use of the integrated technology. Instructors should prepare more student-centered learning tasks to encourage students actively participate in classroom activities and cooperate with their peers [40]. Student-centered learning can assist students in acquiring knowledge and increase their ability to learn. Besides, instructors in the TEL environment should provide instant access to multiple, latest, reliable, relevant and student preferred learning materials [27]. According to [10], well-designed learning materials could increase students' motivation, develop their creativity, evoke prior knowledge and encourage logical thinking and reasoning. Meanwhile, low-quality learning materials and tasks could inhibit the promotion of HOTS among students in the TEL environment. It is important to note that, in order to reap benefit from the integration of technologies in classroom, learning materials should be designed to support the students' learning needs. Therefore, it is important to identify the influence of preparedness of appropriate learning material and task factors to promote HOTS among students in the TEL environment.

Organisational support is considered another important factor that can influence HOTS in the TEL environment. [45] reported that organisational support includes elements such as the education institutes culture promoting technology use in learning, providing technical support and availability of technology policies. Organisational support enables the academicians to make use of the wealth of the available technologies that can influence them to use technology. This consequently can lead to the development of HOTS among students. Additionally, the organisational effort to provide workshops or seminars to guide the instructors to use the technology adequately will lead to professional development ([11]; [43]). An organisation should realise that its sup-

port is an important element to motivate academicians in the adoption of ICT tools. Therefore, this study also identifies the contribution of organisational factors in promoting HOTS in ICT integrated classes.

2 Theoretical framework

This study used the Unified Theory of Acceptance and Use of Technology (UTAUT) (Figure 1) model developed by [62] as its guiding theory. This model was selected because it has high explanation power of the technology adoption. UTAUT describes the influence of four variables on technology adoption. Those variables are performance expectancy, effort expectancy, social influence and facilitating condition. Performance expectancy is the degree to which a person believes that use of the new technology will improve his job performance. Effort expectancy refers to the level of ease of the technology use. Social influence describes that a person changes his behaviour to meet the demands of social environment. Finally, facilitating condition refers to the level to which a person believes that a technical and organisational infrastructure supports use of ICT tools [62]. This study adopted the UTAUT model because it has demonstrated the role of social, physical factors and consumer judgement in determining educator and student behaviour with educational technology ([23]; [54]; [65]).

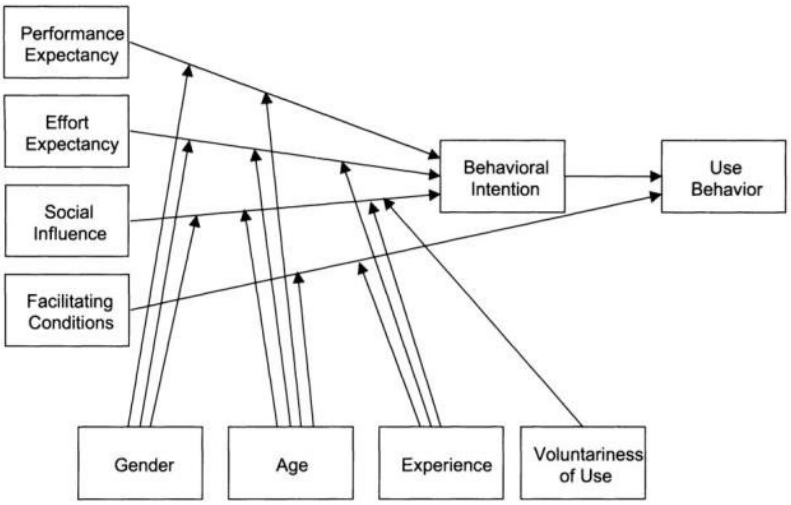

Figure 1: Unified Theory of Acceptance and Use of Technology (UTAUT) Model.

3 Materials and Methods

3.1 Research Design

Descriptive research design was used to collect the data of this study. According to [9] descriptive research design is the appropriate research design if the research is aimed at answering the "what" type of research questions. The current study used descriptive research design because the research aimed to understand the type of ICT tools used by the respondents and the factors that

influence the promotion of HOTS in ICT integrated classes among students. This study used both quantitative and qualitative approaches to collect data from the target respondents. Quantitative approach refers to a "set of strategies, techniques and assumptions used to study psychological, social and economic processes through the exploration of numeric patterns" [20]. Meanwhile, "qualitative approach is a process of naturalistic inquiry that seeks an in-depth understanding of social phenomena within their natural setting" [20]. Quantitative approach was used in this study in order to collect data on the frequency of the type of ICT tools used by respondents and factors that influence the promotion of HOTS in ICT integrated classes. Meanwhile, a qualitative approach was used to obtain a more detailed explanation of how the identified factors influence the promotion of HOTS in ICT integrated classes among the students.

3.2 Respondents

Five research universities in Malaysia that ranked higher for the mathematics subject in QS ranking were invited to participate in the study. Only three universities were willing to participate in the study due to uncertain conditions created by the COVID-19 pandemic. The respondents of the study were selected based on a purposive sampling approach. Purposive sampling approach was selected because the respondents of this study should have experience in integrating technology tools into their teaching and learning activities. 86 academicians from the mathematics department who have experience in integrating technology tools in their teaching and learning activities participated in the study. Out of 86 respondents, 33 academicians were from Institute A, 32 academicians were from Institute B and 21 academicians were from Institute C. The academicians from the mathematics department were selected as the respondents of this study because the examination results of the students from the mathematics department showed poor performance for the questions involving HOTS. This study sought feedback from academicians because academicians can give true evaluation of their students' performance in the TEL environment as they continuously observe and evaluate their students' performance throughout the teaching and learning activities [12]. All the respondents have been using ICT tools for more than three years.

3.3 Data Collection Procedure

Data from this study were collected via questionnaire and face-to-face interviews. The questions were adapted from [1]. The questionnaire consisted of three parts: respondents' demographic details, use of ICT tools and factors that promote HOTS in ICT integrated classes among students. The demographic questions included the respondents' background information. The section on the use of ICT tools gathered background information related to the use of ICT tools by the respondents. The third section gathered details on the factors that promote HOTS in ICT integrated classes among students. This part consists of five constructs, namely the technology factor (3 items), instructor factor (3 items) student factor (4 items), learning material and task factor (2 items) and organisational factor (3 items). The questions related to demographic details consists of dichotomous and rating types of questions. Meanwhile, questions related to use of ICT tools consist of dichotomous scales. Finally, questions related to factors that promote HOTS in ICT integrated classes among students consist of Likert scale questions (1- strongly disagree to 5- strongly agree). Two experts in the field of ICT in education evaluated the validity.

The author identified the respondents who integrated ICT tools in their teaching and learning activities with the help of the head of departments of these three institutions. Then, the author dis-

tributed the questionnaire to the respondents. Meanwhile, the author also conducted face-to-face interviews with eight participants (3 from Institution A, 3 from Institution B and 2 from Institution C) to understand in detail the factors and how those factors promote HOTS in ICT integrated classes among students. The participants for the interview were selected based on purposive sampling approach. These eight participants have experience in integrating basic and advanced ICT tools such as programming software and learning software. The interview questions consisted of semi-structured interview questions. The author conducted face-to-face interviews with the participants and the interviews were tape-recorded. Each interview lasted approximately 40 minutes. The interview protocol consists of questions related to demographic details (gender, profession, working experience) and ICT tools used. Besides, it also consists of questions that intend to explore the factors and how the identified factors influence the promotion of HOTS in ICT integrated classes among students.

3.4 Data analysis

Descriptive and thematic analyses were carried out to analyse the data. Data from the questionnaire were analysed in terms of descriptive analysis, mainly in percentages and frequencies in SPPS 28.0 software. Meanwhile, interview data was analysed in terms of thematic analysis by using constant comparative method suggested by [44] in NVivo 11.0 software. NVivo 11.0 software was used in this study to assist the researcher in identifying the relevant categories from the interview codes and finally group them into respective themes. Constant comparative method was used because it enabled the data to be systematically compared to arrive at the final pattern. At the first stage of constant comparative analysis, the interview data were transcribed verbatim. The analysis process began after the author became familiar with the data. The author became familiar with the data by reading the data several times. Then, the author identified the codes that answered the predetermined research question of the study. Later, codes that have the same meaning were grouped to form categories. The same analysis process was carried out for the second interview transcript. Then, the author compared the categories developed for first set of data with the second set of data to generate themes. The same method was used to analyse the subsequent interview transcripts.

4 Results and Discussion

4.1 Demographic details of the respondents

Among the 86 respondents, there were 56 females and 30 males. There were 56 senior lecturers, 29 Associate Professor and one Professor. All of them were PhD degree holders. Their age ranged from 34 to 63 years old, with an average age of 42.76. All the respondents had more than five years of working experience.

All the respondents used word processing software, presentation software, social media and e-learning portals as this software were the very common software used in the teaching and learning activities of the respondents. Meanwhile, only 22 respondents used database software, 12 respondents used desktop publishing software, 20 respondents used programming software and 24 respondents used learning software in their teaching and learning activities. The respondents reported that they used this software when they taught relevant topics. Table 1 shows the ICT

tools used by the respondents.

Questions related to the skills needed to operate the technologies in teaching and learning activities mostly showed that all the respondents have good skills in using most software, as stated in Table 2. All the respondents stated that they have high skills in operating the word processing software, spreadsheet software, presentation software, social media and learning management software and need minimal guidance to operate software. This is because all the respondents were required to use the stated software in their daily activities and this enabled them to master the skills needed to operate software. Meanwhile, 4 respondents and 12 respondents stated that they have a low and average levels of skills in operating database software, respectively. This is because not all the respondents use the database software for their teaching activities. Therefore, they did not spend much time learning to operate the database software. On the other hand, 65 and 5 respondents stated that they had high and very high skills, respectively to handle the database software. These respondents had experience attending workshops related to database software. In terms of desktop publishing software, 11 and 5 respondents stated that they had a low and middle levels of skills, respectively, in using the software. This is because theses respondents seldom use the software for their teaching and learning activities. On the other hand, most of the respondents stated that they have high (62 respondents) and very high (8 respondents) levels of skills in operating desktop publishing software. Most of these respondents would have attended workshops to learn to use the desktop publishing software. Meanwhile, the majority of respondents stated that they have either high or very high skills in operating programming and learning software. This is due to most of the respondents incorporated the programming and learning software in their teaching and learning activities.

Very low	:	I know only basic things in the software and need guidance.
Low	:	I know to use some advanced features in the software but need guidance.
Middle	:	I know to use most of the advanced features in the software but need guidance.
High	:	I know to use all the features of the software with minimal guidance.
Very High	:	I know to use all the features of the software without guidance.

Table 1: ICT tools used by the academicians.

ICT tools	Frequency
Word processing software	86
Spreadsheet software	20
Presentation software	86
Database software	22
Desktop publishing software	12
Social medias	86
E-learning portal	86
Programming software	20
Learning software	24

Table 2: Skills of Using ICT Tools.

	Not related (n)	Very low (n)	Low (n)	Middle (n)	High (n)	Very high (n)
Word processing software	-	-	-	-	6	80
Spreadsheet software	-	-	-	-	6	80
Presentation software	-	-	-	-	4	82
Database software	-	-	4	12	65	5
Desktop publishing software	-	-	11	5	62	8
Social medias	-	-	-	-	2	84
E-learning portal	-	-	-	-	5	81
Programming software	-	-	5	15	43	23
Learning software	-	-	3	18	52	13

4.2 Factors that promote HOTS in ICT integrated classes

Table 3 shows a summary of the research findings. The table shows that all the respondents agree or strongly agree with the given factors. None of the respondents disagree with the given factors, indicating that all the respondents admitted that technology factor, instructor factor, learner factor, learning material and task factor and organisational factor play important roles in influencing the use of ICT tools by academicians to promote HOTS among students.

The technology factor is described by three characteristics of ICT tools which explain the integration of ICT tools in teaching and learning activities to promote HOTS. These characteristics are perceived ease of use, perceived usefulness and perceived enjoyment. The result indicated that ease of use (93.0%), usefulness for the learning process (100%) and perceived enjoyment (87.2%) strongly influenced the use of ICT tools by academicians to promote HOTS among students. The result clearly showed that if academicians perceive a technology product as easy to use, they will use the technology product frequently. This was because academicians need less mental load to operate it. Therefore, academicians could allocate more time to find ways to promote HOTS appropriately among students. Academicians also found that perceived usefulness was an important determinant in promoting HOTS in the TEL environment. This was because technology can provide useful resources that could promote HOTS effectively. Furthermore, appropriate use of technology could also assist the academicians in helping the students to engage in their subject content. Meanwhile, perceived enjoyment is also a significant predictor that can promote HOTS in the TEL environment. This was because academicians who felt happy when using a technology product was believed to pay more attention to the learning activities that could promote HOTS. These academicians could later engage students in the TEL environment effectively leading to the promotion of HOTS.

Table 3: Summary of findings.

	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Technology factors (n=3 items)										
Ease of use	-	-	-	-	-	-	6	7.0	80	93.0
Useful for learning process	-	-	-	-	-	-	-	-	86	100
Perceived enjoyment	-	-	-	-	-	-	11	12.8	75	87.2
Instructor factors (n= 3 items)										
Attitude towards technology	-	-	-	-	-	-	6	7.0	80	93.0
Self-efficacy	-	-	-	-	-	-	6	7.0	80	93.0
Technology competence	-	-	-	-	-	-	-	-	86	100
Student factors (n= 3 items)										
Attitude towards technology	-	-	-	-	-	-	6	7.0	80	93.0
Self-efficacy	-	-	-	-	-	-	6	7.0	80	93.0
Technology competence	-	-	-	-	-	-	6	7.0	86	100
Support individual learning style	-	-	-	-	-	-	11	12.8	75	87.2
Learning materials and Task factors (n= 2 items)										
Sufficient learning resources	-	-	-	-	-	-	11	12.8	75	87.2
Appropriate task/questions	-	-	-	-	-	-	-	-	86	100
Organisational factor (n= 3 items)										
The faculty/university management provide technical support	-	-	-	-	-	-	11	12.8	75	87.2
The faculty/university management encourage instructors and students to use technology to promote HOTS	-	-	-	-	-	-	16	18.7	70	81.3
The faculty/university management provide workshop/ seminar on how to use technology to promote HOTS	-	-	-	-	-	-	-	-	86	100

Meanwhile, instructors' factors such as attitude towards technology (93.0%), self-efficacy (93.0%) and technology competence (100%) also strongly influence the use of ICT tools to promote HOTS among students. Instructors' attitude towards technology is important in developing students' HOTS in the TEL environment. This is because it will encourage appropriate use of the technology by the instructors in their teaching activities and effectively deliver their lecture to develop HOTS among students. Besides, the higher self-efficacy of the instructors also influences the promotion of HOTS among students. This is because the self- efficacy of the instructors shows their determination to incorporate technologies in their teaching activities effectively, which in turn motivates them to find appropriate methods to develop HOTS among students. Furthermore, instructors' competence in operating the technology also play an important role in promoting HOTS among students. The instructors' higher technology competence enables them to solve any technical errors easily. Therefore, they can pay more attention to the subject content to improve students' HOTS.

Similarly, student factors that include constructs such as attitude towards technology (93.0%), self-efficacy (93.0%), technology competence (100%) and support individual learning style (87.2%) determine the use of technology to promote HOTS. The students' positive attitude towards technology motivates them to integrate the technology appropriately in their learning activities and find ways to integrate more useful technologies that can assist them in developing HOTS. Besides, self-efficacy and technology competence of the students are also found to be the important determinants that can enhance HOTS. Higher self-efficacy and technology competency enables the students to use the technology confidently in their learning activities, and thus allowing them to allocate more time to develop HOTS. Meanwhile, use of technology that can support the individual learning style can also promote HOTS. This is because students can adjust their learning style based on the available technology and divert their attention to the development of HOTS.

Furthermore, learning materials and task factors that include constructs such as sufficient learning resources (87.2%) and appropriate task/questions (100%) are also found to strongly determine ICT use among academicians to promote HOTS among students. It is important to realise that although the instructors integrate advanced technologies into their teaching environment, it is important for the instructors to provide sufficient learning resources to the students so that the students are either not overloaded or provided with irrelevant resources that can demote the promotion of HOTS. Meanwhile, instructors should also prepare appropriate tasks that can develop HOTS among the students in the TEL environment. This is because preparing tasks that are appropriate with the integrated technology can assist the students in developing their HOTS.

Meanwhile, organisational factors that consisted of constructs such as providing technical support (87.2%), encouraging instructors to use technology to promote HOTS (81.3%) and providing workshop/seminar on how to use technology to promote HOTS (100%) were also found to strongly determine ICT use among the academicians to promote HOTS among the students. This is because motivation and encouragement from the organisation can determine continuous and appropriate use of technology by academicians to promote HOTS among students.

The qualitative evidence showed that the academicians view the technological factor as the important factor influencing them to use ICT tools. The academicians stated that the technology factor enables them to use the ICT tools to benefit their teaching activities, whereby the use of ICT tools increases the students' engagement level towards the subject content. The academicians also admitted that they are able to use the ICT tools without much anxiety as the ICT tools are easy to

use. For instance, Fateh and Iqbal stated that:

> *"Use of Youtube, for instance, helps me to demo to my students the concept behind a theory. They watch the video and visualise the application of a theory or an equation. This assists the students in understanding the concept better. Furthermore, it also increases the level of engagement of my student. Thus, I can see some of the students really think critically when a problem is given to them"* (Fateh)

> *"I found the use of ICT tools is easier for me as I attended workshops to learn to operate the tools. I also noticed that students get excited and enjoy it when I integrate ICT tools in my teaching and learning activities. This motivates the student in many ways to learn the subject and engage deeply with the content"* (Iqbal)

Meanwhile, the participants also agreed that the instructor's factor also strongly determined the use of ICT tool and consequently led to the promotion of HOTS among students. The academicians admitted that the academicians' positive attitudes towards the integration of ICT tools is important as it will increase their interest in using the ICT tools and students' interest towards the subject content. Besides, the academicians also admitted that higher self-efficacy in integrating the ICT tools into their teaching activities further motivates them to use the ICT tools without fear. For instance, Aminah and Hassan stated that:

> *"In my opinion, all the academicians should have a positive attitude towards integrating ICT tools in their teaching activities. This will ensure that they feel happy and motivate the students to use ICT in their learning activities which can create a more interesting learning environment to the students and create more options for them to think critically."* (Aminah)

> *"My self-efficacy towards using the ICT tools in my classes is quite high…this assisted me to continue its usage in my classes and take initiatives to integrate more new tools…I hope other lecturers also should have high self-efficacy to integrate the ICT tools."* (Hassan)

Furthermore, the instructors technology competence enabled them to operate the ICT tools confidently and solve technical errors easily. Moreover, they admitted that the use of ICT tools provided a higher satisfaction level because it increased students' understanding level and increases their participation in classes. For example, Omar stated that:

> *"I can use the technology tools without any fear because I have the knowledge in operating it. I also joint some workshops to learn more about operating the tools. So, I can focus more on teaching and guiding my students to enhance their HOTS. Further, use of ICT tools also increase my satisfaction level as its enhanced students' understanding."*

Student factor is another important factor that determine the use of ICT tools to promote HOTS. Without students' commitment, it will be difficult for the instructors to integrate the ICT tools into their teaching activities. Academicians stated that most of the students in their classes showed positive attitudes towards using the ICT tools and enjoyed the learning environment. For instance, Hassan stated that:

> *"I can see my students really enjoyed the use of ICT tools in their classes. They use it to solve problems and discuss solution with their friends…even they use it to collect further resources for their learning activities. I can see different learning environment and students started to think differently. Further they show more positive attitudes."*

Furthermore, the academicians also stated that the students showed higher self-efficacy and had good technology competency. Most of them were able to solve the technical errors encountered in their ICT tools by themselves and showed strong personality in handling the tools. Fateh and Iqbal shared their experience as:

> *"I admire the students' skills in handling the technology…some of the students actually very advance and they solve any problem that they encountered while using the technology."* (Fateh)

> *"The students actually have very high self-efficacy in handling the technology…although at the beginning they are a bit worry in using the technology…but I noticed that later they become the expert users of the technology. This help the students to pay more attention to the content of the course and to understand it better to develop their HOTS."* (Iqbal)

Moreover, the academicians also mentioned that the ICT tools used by them supported the students' individual learning styles. Students used the ICT tools according to their learning needs as some of them used them for deep learning and some used them for surface learning. Hassan admitted that:

> *"Each of my students has different learning strategy. I noticed that, a few students like to use the ICT tools for deep learning where they really look for resources from the Internet and study very deep…meanwhile some students use the Internet resources merely to complete their assignments. The HOTS of students who use deep learning really improved so much"*

Meanwhile, the academicians also surmised that sufficient learning resources, appropriate learning tasks and activities acquiring students' participation in classes were very important in ICT integrated classes to promote HOTS. This was because they admitted that appropriate resources and task were able to engage students in learning activities and at the same time, increased their participation in classes. For instance, Fateh said:

> *"I have to make sure that I provide students with enough learning resources or encourage them to find the resources by themselves…because without the resources it is hard for the students to understand the course….moreover…I also need to carefully design the task…where I will make sure the students use the appropriate ICT tools to solve the questions….another important thing is the student participation in learning activities…my task will ensure that every students in the class to play their role in solving the problem and discuss the answer or problem in front of the class. Further, I will also ensure the questions really invoke students higher order thinking skills"*

The academicians reported that the organisational factor played an important role in integrating ICT tools into classes to promote HOTS. They admitted that the university management's support in providing technical support, encouragement and offering workshop to learn how to use the ICT tools were very important. Aminah said:

"I personally believe that organisational support is very important because it motivates me to use the ICT tools in my classes. The encouragement from the top management and their initiatives in offering workshop to us boost my synergy to use the ICT tools in my classes to promote HOTS among students."

5 Discussion

The findings showed that technology factors such as ease of use, usefulness for learning activities and perceived enjoyment contributed to the use of ICT tools by academicians to promote HOTS among students. The findings were in line with previous studies, which found that perceived ease of use was an important determinant of ICT tools adoption among academicians [61]. According to [21], if a system was easy to use it could reduce mental exertion and encourage the user to use it without much anxiety. The finding was also in agreement with [42] who stated that ease of use of technology products leads the students to focus more on the learning tasks that needed critical thinking development. The finding also supported the effort expectancy construct stated in the UTAUT model. A user needs less effort to operate a technology product; then the user will show more interest in using the technology [62]. Nevertheless, [49] argued that perceived ease of use was not a predictor of ICT adoption among academicians as they stated that ICT tools that were too easy to use will inhibit the academicians to foresee its benefits in their academic work. However, in the current study the respondents stated that they could focus on creating activities that could enhance student HOTS as the respondents could easily operate the technology tools integrated into their classrooms.

Meanwhile, the findings also suggested that all the respondents stated that perceived usefulness was a strong predictor that determine their use of the ICT tools to promote HOTS. It is reported that academicians will use ICT tools if it benefits their teaching and learning activities and meets their needs [46]. Similarly, [58] and [55] argued that academicians will use ICT tools that provided a convincing platform for applying constructivist principles and increase students' engagement level that could lead to the promotion of HOTS. The finding also supported the performance expectancy criteria in the UTAUT model, which highlighted that a user would continue to use a technology product if it could contribute significantly to his performance improvement [62]. Similarly, in the current study, the respondents admitted that the use of technology tools increased students' performance and, at the same time, promoted students' HOTS. The findings showed that the academicians enjoyed the experience of using the ICT tools in their teaching and learning activities, and thus motivated its adoption. The finding was in line with the findings of [50], who stated that relatively some users were very particular about the feeling of enjoyment and delight that they receive when using ICT tools. This leads to the use of new ICT tools to promote HOTS. However, a study by [29] revealed that perceived enjoyment did not influence educators' intention to adopt mobile learning as they were unfamiliar with the ICT tool.

Meanwhile, the study also showed that the educators' and students' factors such as attitude towards technology, self-efficacy, technology competence and support student learning styles influenced the adoption of ICT tools by the educators. Attitude represents the affective components toward ICT tools that include positive and negative feelings about the ICT tools. [21] reported that positive attitudes of the users would determine the technology adoption. Similarly, this study showed that attitudes towards the technology of both educators and students influenced their decision to adopt it. The study was congruent with [57], who stated that the positive attitudes of

instructors and students in the TEL environment could promote HOTS among students. Meanwhile, self-efficacy of the academicians and students was also determined the technology use. This showed that both educators and students believed that they could complete the task or achieve their objectives by using the ICT tools. The finding of this study supported the findings of [68], who reported that students with high self-efficacy were confident in using the ICT tools and completing the given task successfully. Meanwhile, [17] stressed that higher self-efficacy of students in ICT integrated classes could lead to enhancement of HOTS. In addition to that, technology competence also determined the ICT use of the academicians and students. The high skill of operating the ICT tools among academicians and students enabled them to use the ICT tools without fear and solve any technical problems by themselves. Similarly, [30] findings stated that technology competency determined its adoption and led to the promotion of HOTS, which the respondents could use the technology tools without any fear and can focus on completing a task that determined their performance. The current study provided further evidence that technology competency of respondents determined their performance in TEL environment.

Furthermore, the study also showed that the students' learning style also influenced the ICT adoption to promote HOTS. ICT tools that supported the individual learning styles can attract the students to use them in their learning activities. For instance, if a student is engaged in deep learning strategy, the ICT tools that he used should support that style of learning. Then, it would motivate the student to use the relevant ICT tools quite often. The finding supported the findings of [30], who reported that supporting individual learning styles is another important determinant of ICT adoption. Furthermore, it also supported the findings of [15] findings, who stated that students who adopted the deep learning approach in the TEL environment engaged more in higher order thinking activities. However, [48] reported that students' learning style did not influence their ICT adoption and invited more studies to be conducted in this view to explain the contradictory finding.

Learning materials and task factors also influenced the adoption of ICT tools among academicians to promote HOTS. It is important for the academicians to provide access to enough learning resources and, simultaneously provide the appropriate resources to the students as their references. Furthermore, the academicians also should prepare learning task that make use of the ICT integrated in the classes and tasks that can promote HOTS. In addition, the tasks should be able to encourage student's participation in classes and induce them to have more online discussions among peers, lecturers and experts in their field. The finding was consistant with the findings of [14] who stated that appropriate task would envisage students' creative outcomes in technology integrated classes. Similarly, [2] stated that online discussions could promote critical thinking skills and deep learning. It was because online discussion provided a natural framework for the students to discuss among themselves. Meanwhile, [47] stated that providing enough learning resources as reference for academicians and students played important roles in promoting HOTS in technology integrated classes.

The finding of this study also suggested that organisational factors such as the initiative of the faculty/university management to provide technical support, workshops on how to use the ICT tools and encourage the academicians to integrate the ICT tools into their classes promoted HOTS among students. It was important for the top management to provide technical support and workshop for the academicians to use the ICT tools because it would assist them solve technical errors and become competent users of the ICT tools. Besides, encouragement from the top management increased interest among the academicians to integrate ICT tools into the classes. The findings supported the findings of [60], who stated that top management played an important

role in providing support, encouraging and organising workshops to use ICT tools among academicians. This will motivate the academicians to integrate ICT tools in their classes to teach the students and at the same time promote HOTS. In the current study, the respondents also agreed that support for organisation was important for continuous use of technology tools. The finding supported the facilitating condition construct in UTAUT model, which an individual will use technology product if the environment is conducive. In the current study, the organisational support was one of the prominent facilitating conditions that could determine use of technology tools by respondents to promote HOTS among students.

6 Conclusions

This study, which was based on the UTAUT model, aimed to gain a better understanding of the antecedents of ICT adoption by university academicians in their teaching and learning process to promote HOTS among students. The study showed that technology factor, instructor factor, student factor, learning materials and task factor and organisational factor influenced the adoption of ICT tools by academicians to promote HOTS among students. The results of the study yielded several practical implications. First, the study contributed to expanding readers' understanding of the factors that influence the use of ICT tools by academicians in their teaching and learning activities to promote HOTS among students. The author provided empirical evidence as, why these factors helped to explain ICT tools integration into teaching and learning to promote HOTS among students. Besides, it also showed specifically to an organisation that their support is one of the prominent factors that determine the success of HOTS enhancement in the TEL environment.

Future studies are recommended to investigate more new factors such as cultural and environmental factors that can influence the promotion of HOTS among students from different cultural backgrounds in the TEL environment.

Acknowledgement This work was supported by the Universiti Putra Malaysia under Putra Research Grant with vote number 9645800.

Conflicts of Interest The authors declare no conflict of interest.

References

[1] M. M. M. Abbad (2021). Using the UTAUT model to understand students' usage of e-learning systems in developing countries. *Education and Information Technologies*, *26*(6), 7205–7224. https://doi.org/10.1007/s10639-021-10573-5.

[2] M. K. Afify (2019). The influence of group size in the asynchronous online discussions on the development of critical thinking skills, and on improving students' performance in online discussion forum. *International Journal of Emerging Technologies in Learning*, *14*(5), 132–151. https://doi.org/10.3991/ijet.v14i05.9351.

[3] S. Alharbi & S. Drew (2014). Using the technology acceptance model in understanding academics behavioural intention to use learning management systems. *International Jour-*

nal of Advanced Computer Science and Applications, *5*(1), 143–155. http://dx.doi.org/10.14569/IJACSA.2014.050120.

[4] S. N. Ali (2014). *Malaysian Polytechnic lecturers' teaching practices with ICT utilization to promote higher-order thinking skills*. PhD thesis, Iowa State University, United States.

[5] I. Y. Alyoussef (2021). E-learning acceptance: The role of task-technology fit as sustainability in higher education. *Sustainability*, *13*(11), 6450. http://dx.doi.org/10.3390/su13116450.

[6] C. J. Bailey & K. A. Card (2009). Effective pedagogical practices for online teaching: Perception of experienced instructors. *The Internet and Higher Education*, *12*(3-4), 152–155. http://dx.doi.org/10.1016/j.iheduc.2009.08.002.

[7] N. R. Betka (2017). EFL learners' higher order thinking and technology based instruction in literature case study of Biskra Univesity 2nd year students. *Arab World English Journal*, *8*(2), 362–370. http://dx.doi.org/10.24093/awej/vol8no2.26.

[8] B. S. Bloom (1956). *Taxonomy of educational objectives: The classification of educational goals*. Longmans, Green, London.

[9] W. R. Borg & M. D. Gall (1989). *Educational Research: An Introduction*. Longman, White Plains, New York.

[10] R. Bušljeta (2013). Effective use of teaching and learning resources. *Czech-Polish Historical and Pedagogical Journal*, *5*(2), 55–69. http://dx.doi.org/10.2478/cphpj-2013-0014.

[11] A. Caliskan & C. Zhu (2020). Organizational culture and educational innovations in Turkish higher education: Perceptions and reactions of students. *Educational Sciences: Theory and Practice*, *20*(1), 20–39. http://dx.doi.org/10.12738/jestp.2020.1.003.

[12] M. D. Camp (2011). *The power of teacher-student relationships in determining student success*. PhD thesis, University of Missouri-Kansas City, United States.

[13] M. Ceberio, J. M. Almudí & Á. Franco (2016). Design and application of interactive simulations in problem-solving in university-level physics education. *Journal of Science Education and Technology*, *25*(4), 590–609. http://dx.doi.org/10.1007/s10956-016-9615-7.

[14] L. Chandler & A. Ward (2019). Immersed in design: using an immersive teaching space to visualise design solutions. *International Journal of Art and Design Education*, *38*(2), 314–327. http://dx.doi.org/10.1111/jade.12191.

[15] P. S. D. Chen, A. D. Lambert & K. R. Guidry (2010). Engaging online learners: The impact of Web-based learning technology on college student engagement. *Computers and Education*, *54*(4), 1222–1232. http://dx.doi.org/10.1016/j.compedu.2009.11.008.

[16] Y. Chen, N. S. Chen & C. C. Tsai (2009). The use of online synchronous discussion for web-based professional development for teachers. *Computers and Education*, *53*(4), 1155–1166. http://dx.doi.org/10.1016/j.compedu.2009.05.026.

[17] Y. L. Chen (2014). A study on student self-efficacy and technology acceptance model within an online task-based learning environment. *Journal of Computers*, *9*(1), 34–43. http://dx.doi.org/10.4304/jcp.9.1.34-43.

[18] C. C. Chinedu, O. S. Olabiyi & Y. Kamin (2015). Strategies for improving higher order thinking skills in teaching and learning of design and technology education. *Journal of Technical Education and Training*, *7*(2), 35–43.

[19] G. Chittleborough, W. Jobling, P. Hubber & G. Calnin (2008). The use of web 2.0 technologies to promote higher order thinking skills. *In AARE 2008: International Education Research Conference-Brisbane,*. Australian Association for Research in Education.

[20] D. Coghlan & M. Brydon-Miller (2014). *The SAGE encyclopedia of action research*. SAGE Publications Ltd, London.

[21] F. D. Davis (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319–339. http://dx.doi.org/10.2307/249008.

[22] F. D. Davis, R. P. Bagozzi & P. R. Warshaw (1992). Extrinsic and intrinsic motivation to use computers in the workplace. *Journal of Applied Social Psychology*, *22*(14), 1111–1132. https://doi.org/10.1111/j.1559-1816.1992.tb00945.x.

[23] M. El-Masri & A. Tarhini (2017). Factors affecting the adoption of e-learning systems in Qatar and Usa: Extending the unified theory of acceptance and use of technology 2 UTAUT2). *Educational Technology Research and Development*, *65*(3), 1–21. http://dx.doi.org/10.1007/s11423-016-9508-8.

[24] Z. Hanapi & M. S. Nordin (2014). Unemployment among Malaysia graduates: Graduates attributes, lecturers competency and quality of education. *Procedia-Social and Behavioral Sciences*, *112*(2014), 1056–1063. http://dx.doi.org/10.1016/j.sbspro.2014.01.1269.

[25] L. B. Horodyskyj, C. Mead, Z. Belinson, S. Buxner, S. Semken & A. D. Anbar (2018). Habitable worlds: Delivering on the promises of online education. *Astrobiology*, *18*(1), 86–99. http://dx.doi.org/10.1089/ast.2016.1550.

[26] P. Howie & R. Bagnall (2013). A critique of the deep and surface approaches to learning model. *Teaching in Higher Education*, *18*(4), 389–400. http://dx.doi.org/10.1080/13562517.2012.733689.

[27] I. Hussain, O. Cakir & U. Candeğer (2018). Social media as a learning technology for university students. *International Journal of Instruction*, *11*(2), 281–296. http://dx.doi.org/10.12973/iji.2018.11219a.

[28] N. N. Ibrahim, A. F. M. Ayub, A. S. M. Yunus & R. Mahmud (2019). Effects of higher order thinking module approach on pupils' performance at primary rural school. *Malaysian Journal of Mathematical Sciences*, *13*(2), 211–229.

[29] S. Iqbal & I. A. Qureshi (2012). M-learning adoption: A perspective from a developing country. *International Review of Research in Open and Distributed Learning*, *13*(3), 147–164. http://dx.doi.org/10.19173/irrodl.v13i3.1152.

[30] O. F. Islim & N. Sevim Cirak (2017). Technology and college students: What faculty members think about the use of technology in higher education. *Malaysian Online Journal of Educational Technology*, *5*(2), 34–50. https://doi.org/10.17576/3L-2017-2301-06.

[31] C. S. Johnson (2017). Collaborative technologies, higher order thinking and self-sufficient learning: A case study of adult learners. *Research in Learning Technology*, *25*, 1–17. http://dx.doi.org/10.25304/rlt.v25.1981.

[32] A. Kirkwood (2006). Getting networked learning in context: are on-line studentsâ technical and information literacy skills adequate and appropriate? *Learning, Media and Technology*, *31*(2), 117–131. http://dx.doi.org/10.1080/17439880600756654.

[33] R. B. Kvavik (2005). Convenience, communications, and control: How students use technology. *Educating the net generation*, *1*, 7–11.

[34] R. Lawrence, L. Ching & H. Abdullah (2019). Strengths and weaknesses of education 4.0 in the higher education institution. *International Journal of Innovative Technology and Exploring Engineering*, *9*, 511–519. https://doi.org/10.35940/ijitee.B1122.1292S319.

[35] J. Lee & H. Choi (2017). What affects learner's higher-order thinking in technology-enhanced learning environments? the effects of learner factors. *Computers and Education*, *115*, 143–152. http://dx.doi.org/10.1016/j.compedu.2017.06.015.

[36] C. W. Lin, E. H. Chang, D. L. Clinciu, Y. T. Peng, W. C. Huang, C. C. Wu, J. C. Wu & Y. C. Li (2018). Using modified information delivery to enhance the traditional pharmacy OSCE program at TMU a pilot study. *Computer Methods and Programs in Biomedicine*, *158*, 147–152. http://dx.doi.org/10.1016/j.cmpb.2017.11.006.

[37] C. Y. Lin, C. K. Huang & C. J. Ko (2020). The impact of perceived enjoyment on team effectiveness and individual learning in a blended learning business course: The mediating effect of knowledge sharing. *Australasian Journal of Educational Technology*, *36*(1), 126–141. http://dx.doi.org/10.14742/ajet.4446.

[38] Y. T. Lin (2019). Impacts of a flipped classroom with a smart learning diagnosis system on students' learning performance, perception, and problem solving ability in a software engineering course. *Computers in Human Behavior*, *95*, 187–196. http://dx.doi.org/10.1016/j.chb.2018.11.036.

[39] A. Littlejohn, A. Margaryan & G. Vojt (2010). Exploring students' use of ICT and expectations of learning methods. *Electronic Journal of e-learning*, *8*(1), 13–20.

[40] H. H. Liu & Y. S. Su (2018). Effects of using task-driven classroom teaching on studentsâ learning attitudes and learning effectiveness in an information technology course. *Sustainability*, *10*(11), 3957. http://dx.doi.org/10.3390/su10113957.

[41] K. Liza & E. Andriyanti (2020). Digital literacy scale of english pre-service teachers and their perceived readiness toward the application of digital technologies. *Journal of Education and Learning*, *14*(1), 74–79. http://dx.doi.org/10.11591/edulearn.v14i1.13925.

[42] K. S. Mac Callum. Influences on the adoption of mobile technology by students and teachers 2011. Doctoral Dissertation, Massey University.

[43] S. Marshall & S. Francis (2010). Change, technology and higher education: are universities capable of organisational change? *ALT-J Research in Learning Technology*, *18*(3), 179–192. http://dx.doi.org/10.1080/09687769.2010.529107.

[44] S. B. Merriam (2009). *Qualitative research: A guide to design and implementation*. John Wiley and Sons, San Francisco, California.

[45] B. Moeller & T. Reitzes (2011). Integrating technology with student-centered learning: A report to the Nellie Mae Education Foundation. *Education Development Center, Inc*,. Quincy, MA: Nellie Mae Education Foundation.

[46] A. G. M. M. Mohamad, S. Z. S. Idrus & A. A. E. A. Ibrahim (2018). The ICT-induced on behavioral of lecturer and society change in Libya Universities. *Journal of Physics: Conference Series*, *1019*(1), 012069. http://dx.doi.org/10.1088/1742-6596/1019/1/012069.

[47] D. Morin, J. D. Thomas & R. G. Saadé (2015). Fostering problem-solving in a virtual environment. *Journal of Information Technology Education*, *14*, 339–362. http://dx.doi.org/10.28945/2273.

[48] N. Moussa (2018). Learning styles and the adoption of modern technology among adult learners. *Institute for Learning Styles Journal*, *1*, 11–21.

[49] Ngabiyanto, A. Nurkhin, Widiyanto, I. H. Saputro & A. M. Kholid (2021). Teacher's intention to use online learning; an extended technology acceptance model TAM investigation. *Journal of Physics: Conference Series*, *1783*(1), 012123. https://dx.doi.org/10.1088/1742-6596/1783/1/012123.

[50] D. Nguyen. Understanding perceived enjoyment and continuance intention in mobile games 2015. Master dissertation, Aalto University).

[51] N. D. Oye, N. A.Lahad & N. Ab.Rahim (2012). Computer self-efficacy, anxiety and attitudes towards use of technology among university academicians: a case study of university of Port HarcourtâNigeria. *International Journal of Computer Science and Technology*, *3*(1), 213–219.

[52] R. Poppy (2013). E-learning to improve higher order thinking skills (HOTS) of students. *Journal of Education and Learning*, *7*(2), 109–120.

[53] D. Pundak, O. Herscovitz, M. Shaham & R. Wiser-Biton (2009). Instructors' attitudes toward active learning. *Interdisciplinary Journal of E-Learning and Learning Objects*, *5*(1), 215–232. http://dx.doi.org/10.28945/74.

[54] A. Raman & Y. Don (2013). Preservice teachers' acceptance of learning management software: An application of the UTAUT2 model. *International Education Studies*, *6*(7), 157–164. http://dx.doi.org/10.5539/ies.v6n7p157.

[55] L. A. Schindler, G. J. Burkholder, O. A. Morad & C. Marsh (2017). Computer-based technology and student engagement: a critical review of the literature. *International Journal of Educational Technology in Higher Education*, *14*(1), 1–28. http://dx.doi.org/10.1186/s41239-017-0063-0.

[56] C. K. S. Singh & P. Marappan (2020). A review of research on the importance of higher order thinking skills (HOTS) in teaching english language. *Journal of Critical Reviews*, *7*(8), 740–747.

[57] V. Šinigoj & S. Avsec (2016). Attitudes and perception of future teachers toward design and technology. *World Transactions on Engineering and Technology Education*, *14*(4), 489–494.

[58] D. Subran. Developing higher-order thinking skills with ICT 2013. Retrived from http://hdl.handle.net/2139/15701.

[59] M. Tajuddin, R. A. Tarmizi, W. Z. Wan Ali & M. M. Konting (2007). The Effects of Using Graphic Calculator in Teaching and Learning of Mathematics. *Malaysian Journal of Mathematical Sciences*, *1*(1), 45–61.

[60] A. Tarhini, K. Hone & X. Liu (2015). A cross-cultural examination of the impact of social, organisational and individual factors on educational technology acceptance between British and Lebanese university students. *British Journal of Educational Technology*, *46*(4), 739–755. http://dx.doi.org/10.1111/bjet.12169.

[61] V. Teeroovengadum, N. Heeraman & B. Jugurnath (2017). Examining the antecedents of ICT adoption in education using an extended technology acceptance model (TAM). *International Journal of Education and Development Using ICT*, *13*(3), 4–23.

[62] V. Venkatesh, M. G. Morris, G. B. Davis & F. D. Davis (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, *27*(3), 425–478. http://dx.doi.org/10.2307/30036540.

[63] A. I. Wang & R. Tahir (2020). The effect of using kahoot! for learning–a literature review. *Computers & Education*, *149*, 103818. http://dx.doi.org/10.1016/j.compedu.2020.103818.

[64] L. M. Wei, C. Y. Piaw, S. Kannan & S. A. Moulod (2016). Relationship between teacher ICT competency and teacher acceptance and use of School Management System (SMS). *Malaysian Online Journal of Educational Technology*, *4*(4), 36–52.

[65] S. Yang (2013). Understanding undergraduate students' adoption of mobile learning model: A perspective of the extended UTAUT2. *Journal of Convergence Information Technology*, *8*(10), 969–979.

[66] H. B. Yılmaz (2017). On the development and measurement of spatial ability. *International Electronic Journal of Elementary Education*, *1*(2), 83–96.

[67] L. Zhao, Y. Lu, B. Wang & W. Huang (2011). What makes them happy and curious online? An empirical study on high school students' internet use from a self-determination theory perspective. *Computers and Education*, *56*(2), 346–356. http://dx.doi.org/10.1016/j.compedu.2010.08.006.

[68] J. Zheng, S. Li & Y. Zheng (2017). Students' technology acceptance, motivation and self-efficacy towards the schoolbag: an exploratory study. *International Journal of Infonomics*, *10*(3), 1350–1358. http://dx.doi.org/10.20533/iji.1742.4712.2017.0165.