Journal of Advanced Research in Applied Sciences and Engineering Technology

Journal homepage:
https://semarakilmu.com.my/journals/index.php/applied_sciences_eng_tech/index
ISSN: 2462-1943

Utilize Fuzzy Delphi Method to Design and Develop T2IG Application for Primary Schools

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ARTICLE INFO

Article history:
Received 3 May 2023
Received in revised form 13 August 2023
Accepted 20 August 2023
Available online 4 September 2023

Keywords:
T2IG; artificial intelligence; instructional material; Fuzzy Delphi Method

ABSTRACT

Education has encountered multiple transformations in tandem with the globalisation of society. Technology is an essential tool for conducting teaching and learning activities. COVID-19 pre- and post-education also emphasize the importance of technology in accessing education. This study aims to develop a Text to Infographic (T2IG) application. T2IG is an application that developed on two platforms, namely in the form of a website and a smartphone application. Users (students) upload text, and the Google Cloud Platform Artificial Intelligence components will translate it into a graphical form containing information. In addition, Google Cloud Platform Artificial Intelligence will quote actual contents from the entire text uploaded by the user. In this study, the process of gathering experts' consensus to identify the application's elements and components that should be used as the application's primary function. The Fuzzy Delphi Method was used to identify the consensus of the experts through a questionnaire. Using the Fuzzy Delphi technique is to get concessions from experts on the development of instructional materials. This method involves the use of fuzzy set theory which has been integrated with the classic Delphi method. The use of this technique helps in determining the requirements of the elements that are important in the development of instructional materials in detail. A total of 12 experts were identified using the expert sampling method. These 12 experts are among lecturers and officials from the fields of education, technology and language who are currently working at the University, Teaching Institutions and the Department of Education. The study identified seven key components and 25 sub-constructs that should be used in the development of the T2IG application. The findings highlight the importance of using technology to enhance teaching and learning activities and the significance of experts' opinions in the development of instructional materials. Twelve study experts accepted a total of six components. The findings of this study have implications for the development of instructional applications that will be developed. This study's findings also emphasise the appropriate components for developing T2IG applications as proposed.

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https://doi.org/10.37934/araset.32.1.378389

1. Introduction

Education is an asset for the development of a country in ensuring the development of quality human capital and being able to compete on the world stage. Accordingly, the education system is designed and implemented based on the development and demand of the world market. According to Al-Qozani and Aleryani [1], 21st-century education has become a significant practice in the education system in Malaysia. Developments and advances in the field of technology today play a significant role in life. The 21st-century era is often considered to be the era of technology [2]. It is also seen as the basis of economic growth of a country where the effect can be felt in every field, one of which may be education. The pandemic of Covid-19 pandemic has had a drastic impact on the world education system [3].

Based on a report by the United Nations Educational, Scientific and Cultural Organization [4], as many as 74% of students worldwide are affected by this Covid-19 pandemic. This situation makes teachers and students rely solely on technology to collaborate to access education. Directly, this situation, especially the post-Covid-19 situation, has applied the importance of the use of technology in the world of education.

Utilizing technology in education is a modern phenomenon. However, the practice of heutagogy education can be achieved by combining methods and approaches according to the changing trends in the world of technology by employing the most recent methods, such as Artificial Intelligence (AI), which is artificial intelligence in education. By physically addressing the demands of the teacher, the heutagogy learning style enables students to select learning techniques based on suitability. Even if education stagnates during the pandemic, this is highly important for pupils to access learning.

The previous studies have contributed to raising awareness of the importance of technology in education, especially in the current era of the Covid-19 pandemic. These studies have highlighted the significance of 21st-century education in the Malaysian education system, the importance of technology in the 21st-century era, its role in economic growth, including education, and the impact of the Covid-19 pandemic on the world education system. The statistical evidence provided by these studies has emphasized the extent of the impact of the pandemic on students worldwide. These contributions have provided the basis for the development of the T2IG application for Malay language instruction for elementary school pupils, which aims to utilize technology and the latest methods, such as Artificial Intelligence (AI), to achieve the heutagogy learning style and enable students to select learning techniques based on suitability, despite the stagnation of education during the pandemic.

2. Artificial Intelligence based Instructional Material

Artificial intelligence is a technique that was introduced as early as 1955 [5]. However, integration into education is challenging. The UNESCO Annual Education Report reveals that the inherent difficulty in recognizing the aspects of this technology that must be assimilated contributes to the difficulty in accepting artificial intelligence in the classroom setting [4]. According to Albahri *et al.,* [2], one of the most attractive features of computer-supported collaborative learning occurs when students are not in the same physical area. This gives students the freedom to decide how far and where they wish to study.

AI systems are utilized to monitor discussion groups, providing professors with information on discussion and student support to facilitate student engagement and learning [6]. Next in 2016, the Chinese Ministry of Education mandated that each local education department contribute at least 8% of its budget to the digitization of education [7]. With 95% of schools connected to the internet,

the United States is prepared to conduct the largest digital education experiment in the world. The experimental construction of an essay-correcting software utilizing artificial intelligence algorithms has been one of China's greatest triumphs to date. The country began collaborating with 60,000 schools to implement an automated essay correcting system with a 92% human-equivalent rate of accuracy [8].

Many educators are familiar with artificial intelligence technology [8]. However, some instructors are still hesitant or unwilling to include artificial intelligence into their teaching practices. In the meanwhile, Ministry of Education Malaysia [9] asserts that despite the fact that all nations have begun employing artificial intelligence in education, a policy must be created to ensure that its adoption becomes a reality.

3. Architecture of T2IG Application

T2IG is an acronym for Text to InfoGraphic, which is the primary function of this developed application. Application architecture and design include several contributing factors such as user needs in the need's analysis phase, quality attributes, design, and information technology environment. The T2IG application is developed on two platforms, namely in the form of a website and a smartphone application. Users (students) upload text, and the GCP Cloud and GCP AI components will translate it into a graphical form containing information. In addition, GCP AI will quote actual contents from the entire text uploaded by the user.

The T2IG application has seven main functions that allow students to use it to translate text into infographics. The primary users of this application are students and are also given facilities for teachers to access this application. Users can enter the interface of the function or select other functions. Among the proposed components or functions are standard curriculum and assessment documents, T2IG application usage guide components, passages, an example of an essay, T2IG application components, language translation facilities and text synopsis components. This T2IG can receive user input through long text and generate it as infographics containing important content. This application uses a text analytics model that is Natural Language Processing (NLP) and the Bayesian Network model to predict the main contents of lengthy text and then transfer it into an infographic [10].

As shown in Figure 1 below the application has several benefits, including the ability to help students better understand and retain information, as visual representations can aid in the comprehension and recall of complex concepts. The T2IG application can also help to promote creativity, as students can experiment with different layouts, colors, and images to create unique and engaging infographics. In addition, the T2IG application can help to save time and reduce the workload of teachers, as it can automate the process of creating instructional materials. Overall, as shown in Figure 1, the T2IG application has the potential to be a valuable tool for improving the quality and effectiveness of instructional materials in the field of education.

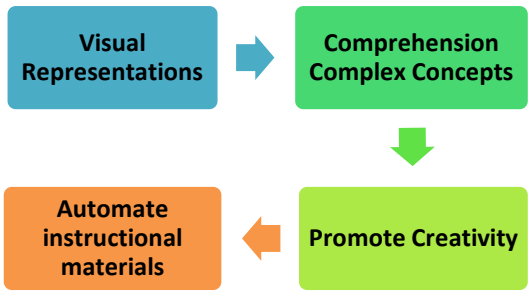

Fig. 1. Advantages and uses of T2IG

4. Methodology

This section discusses the design and development phase of T2IG applications. Researchers used the Fuzzy Delphi method to obtain the expert consensus in the design and development phase of T2IG applications. The FDM is used because it allows for the incorporation of the opinions of experts who have different perspectives and ideas on a particular issue or problem. It takes into account the inherent uncertainty and ambiguity in the responses of the experts, allowing them to express their opinions in a more nuanced and flexible way than in traditional Delphi methods.

4.1 Study Design and Sampling Method

This section discusses the design and development phase of T2IG applications. Researchers used the Fuzzy Delphi method to obtain expert agreement in the design and development phase of T2IG applications. The Fuzzy Delphi technique can be used to obtain expert consensus on a problem [11]. Thus, to answer the research questions that have been stated, the researcher has developed a seven-point questionnaire. In the questionnaire, the experts acted to determine the elements that need to be integrated in the development of T2IG applications. For that purpose, the researcher selected 12 experts in education, language and technology by using a purposeful sampling method, namely expert sampling. The researcher has set some criteria in determining the sample selected as experts: to have extensive experience in the field and hold positions in the field. The following is a list of study experts (Table 1): This section discusses the design and development phase of T2IG applications. Researchers used the Fuzzy Delphi method to obtain the expert consensus in the design and development phase of T2IG applications.

Table 1
List of Experts

Expert	Position	Expertise	Experience
E1	Assistant Director (MoE)	Information Technology	30
E2	Associate Professor	Language	35
E3	Associate Professor	Information Technology	12
E4	Associate Professor	Information Technology	33
E5	Senior Principal Assistant Director (MoE)	Language	31
E6	Chief Assistant Director (MoE)	Information Technology	35
E7	Assistant District Education Officer	Information Technology	11
E8	Assistant Director (MoE)	Information Technology	29
E9	Chief Assistant Director (MoE)	Language	28
E10	Assistant Director (MoE)	Information Technology	20
E11	Senior Software Engineer	Information Technology	22
E12	Software Engineer	Information Technology	18

4.2 Data Collection

This study has been granted approval by the university's ethics committee Ethics Committee Sultan Idris Education University UPSI/PPPI/PYK/ETIKA(M)/014) (378). Ministry of Education (MoE) Malaysia's Educational Planning and Research Division (EPRD) has obtained ethical approval for this study because the sample for this study was collected from government educational institutions. After obtaining ethical permission, all prospective participants were contacted online and invited to participate in this study. Participants were emailed formal invitation letters, information sheets, and

consent forms. Individual consent forms were acquired before the study was conducted (See Appendix 1). The researcher was also accountable for data security and confidentiality.

4.3 Data Analysis Method

The method of data analysis in this study begins with the process of determining the distance to identify the value of Threshold "d". Threshold values are particularly important in the process of identifying the level of agreement between experts [12]. The distances for each fuzzy number m= (m_1, m_2, m_3) and n = (n_1, n_2, n_3) were calculated using the formula [13]:

$$d(m, n) = \sqrt{\frac{1}{3}[(m_1 - n_1)2 + (m_2 - n_2)2 + (m_3 - n_3)2]}. \quad (1)$$

The threshold value is very important in determining the consensus between experts. Expert consensus is calculated to be reached if the threshold value is less than or equal to 0.2 (<0.2) while overall agreement should exceed 75% consensus for each item, otherwise a second round should be implemented.

Next, the process determines the percentage of group consensus. The group consensus percentage must exceed 75%. The overall percentage of agreement should exceed 75% (> 75%) of consensus for each item, otherwise the item or construct should be discarded or a second round should be implemented. If the overall percentage reaches the percentage value as set, then it is calculated to have reached the consensus of the expert group.

The next step is to identify the aggregate alpha level of the Fuzzy rating. Once expert consensus is obtained by adding fuzzy numbers for each item [11]. The calculation and determination of fuzzy values is by using the formula Amax = (1)/4 ($m_1 + m_2 + m_3$). The sixth step is the defuzzification process phase. Defuzzification is the process of providing information about the level of importance of a variable [14]. There are three formulas that can be applied, namely:

$$A = 1/3 * (m_1 + m_2 + m_3)$$
$$A = 1/4 * (m_1 + m_2 + m_3) \quad (2)$$
$$A = 1/6 * (m_1 + m_2 + m_3)$$

The value taken into account is the value of α-cut which is the median value of “0” and “1”, where α-cut = (0 + 1) 2 = 0.5. The use of α-cut values can be used in the defuzzification process [11]. If the resulting value of A is less than the value of α-cut = 0.5, the item will be rejected. An α-cut value less than 0.5 indicates expert agreement rejecting the item and vice versa that exceeding 0.5 indicates expert agreement on the item Based on these measures the researcher will find out whether the items should be rejected or accepted. Constructs and Items received are taken into account in designing the development of the module. The defuzzification value indicates the ranking of the proposed items.

The last step is the process of determining the position (ranking). The ranking is based on the value of defuzzification based on the consensus of the expert with the highest value determined the most prominent position [15]. Value of defuzzification to determine the consensus of expert consensus [14]. The positioning process is determined through the formula ai [6]. The formula is = Ai = ($ai_1 + 2ai_2 + ai_3$) defuzzied by ai = ¼ ($ai_1 + 2ai_2 + ai_3$). Once the data were obtained, data analysis was performed. All these levels and steps of analysis were analysed using Microsoft Office Excel software

to analyse Fuzzy Delphi data. The T2IG application was designed and developed by the researchers using Fuzzy Delphi data analysis in this phase.

5. Findings

A total of 12 experts were involved in this study to determine consensus on the items and arrangement of the proposed components. A number of component headings have been identified based on the literature review. Among the proposed components are standard curriculum and assessment documents, T2IG application usage guide components, an example of a passages, an example of an essay, T2IG application components, language translation facilities and text synopsis components. A total of 25 have been listed in these seven components to ensure that the development of T2IG applications meets the needs of users.

5.1 Analysis of Expert Consensus on T2IG Application Design and Development

Table 2 shows the items listed in the seven components of T2IG application development. A total of 25 items were listed under this first component as in Table 2.

Table 2
Items of T2IG Component

Items	
A1	The importance of DSKP is explained.
A2	DSKP years 4 to 6 are loaded.
A3	A list of Content Standards and Learning Standards related to writing skills is listed.
B1	The purpose of T2IG application development is explained.
B2	The function of each component of the T2IG application is explained.
B3	A description of the users of the T2IG application is explained.
C1	The purpose of this component is explained.
C2	Examples of excerpts from the textbook are loaded in the T2IG app.
C3	All examples of citations are loaded according to the suitability of the school year.
C4	A total of five passages were provided from the textbook for each degree.
D1	The purpose of this component is explained.
D2	Examples of essays from textbooks are loaded in the T2IG app.
D3	All examples of essays are loaded according to the suitability of the year of study.
D4	At least one sample essay is loaded according to the type of essay.
E1	The purpose of this component is explained.
E2	Artificial intelligence elements according to the Text Analytics model are loaded.
E3	Users are given the facility to upload or copy paste a selection of generated text to the graphic.
E4	Elements of artificial intelligence can generate graphics with minimal input from the user.
E5	The functionality in T2IG needs to be user friendly.
F1	The purpose of this component is explained.
F2	Language translation functions are provided for Tamil, Chinese and English at least.
F3	The accuracy of the language translation can be ensured.
G1	The purpose of this component is explained.
G2	The function of generating a synopsis or summary of the text is provided.
G3	Synopsis generation in line with user -loaded graphics and excerpts.

Table 3 shows the consensus findings of the experts of this first component where all three were accepted by 12 experts. The majority of experts have received items under the standard components of curriculum and assessment documents. Under this component, the importance of content standard documents as well as a list of content standards related to writing are listed.

Table 3
Finding of Experts Consensus on standard curriculum and assessment documents

Item	Conditions of Triangular Fuzzy numbers		Conditions of Defuzzification Process	Position	Experts Consensus
	Threshold Value, d	Percentage of Experts Group Consensus, %	Fuzzy Score (A)		
A1	0.095	92%	0.919	19	Accepted
A2	0.095	92%	0.919	19	Accepted
A3	0.087	92%	0.928	16	Accepted

Condition:
Triangular Fuzzy Numbers
1) Threshold Value (d) ≤ 0.2
2) Percentage of experts Consensus > 75%
Defuzzification Process
3) Fuzzy Score (A) ≥ α – cut value = 0.5

Table 4 shows the consensus findings on T2IG application usage guide components were accepted by 12 experts. The majority of experts have received items under the application usage guide components. Under this component, the importance and requirements of the preparation of the T2IG application guide are listed.

Table 4
Finding of Experts Consensus on T2IG application usage guide components

Item	Conditions of Triangular Fuzzy numbers		Conditions of Defuzzification Process	Position	Experts Consensus
	Threshold Value, d	Percentage of Experts Group Consensus, %	Fuzzy Score (A)		
B1	0.068	100%	0.933	10	Accepted
B2	0.087	92%	0.928	16	Accepted
B3	0.075	92%	0.936	8	Accepted

Condition:
Triangular Fuzzy Numbers
1) Threshold Value (d) ≤ 0.2
2) Percentage of experts Consensus > 75%
Defuzzification Process
3) Fuzzy Score (A) ≥ α – cut value = 0.5

Based on the analysis in Table 5 using Fuzzy Delphi Method showing that all the time accepted by the 12 experts. All the items show fuzzy score (A) more than 0.910. In this component expert's emphasis about the passages that include in the T2IG application to end user.

Table 5
Finding of Experts Consensus on example of a passages

Item	Conditions of Triangular Fuzzy numbers		Conditions of Defuzzification Process	Position	Experts Consensus
	Threshold Value, d	Percentage of Experts Group Consensus, %	Fuzzy Score (A)		
C1	0.117	83%	0.914	22	Accepted
C2	0.087	92%	0.928	11	Accepted
C3	0.075	92%	0.936	8	Accepted
C4	0.109	83%	0.922	18	Accepted

Condition: SS
Triangular Fuzzy Numbers
1) Threshold Value (d) ≤ 0.2
2) Percentage of experts Consensus > 75%
Defuzzification Process
3) Fuzzy Score (A) ≥ α – cut value = 0.5

Based on the analysis in Table 6. using Fuzzy Delphi Method showing that all the time accepted by the 12 experts. All the items show fuzzy score (A) more than 0.920. In this component expert's emphasis about the essays that include in the T2IG application to end user.

Table 6
Finding of Experts Consensus on example of an Essay

Item	Conditions of Triangular Fuzzy numbers		Conditions of Defuzzification Process	Position	Experts Consensus
	Threshold Value, d	Percentage of Experts Group Consensus, %	Fuzzy Score (A)		
D1	0.023	100%	0.958	1	Accepted
D2	0.095	92%	0.919	19	Accepted
D3	0.087	92%	0.928	11	Accepted
D4	0.087	92%	0.928	11	Accepted

Condition:
Triangular Fuzzy Numbers
1) Threshold Value (d) ≤ 0.2
2) Percentage of experts Consensus > 75%
Defuzzification Process
3) Fuzzy Score (A) ≥ α – cut value = 0.5

As listed in Table 7, five items listed to 12 experts permit the consensus on the main functions available in T2IG application. All the five items accepted by the experts and fuzzy score (A) for all item is minimum 0.928. It shows experts permitted the main functions suggested by the researcher.

Table 7
Finding of Experts Consensus on T2IG Application Components

Item	Conditions of Triangular Fuzzy numbers		Conditions of Defuzzification Process	Position	Experts Consensus
	Threshold Value, d	Percentage of Experts Group Consensus, %	Fuzzy Score (A)		
E1	0.023	100%	0.958	1	Accepted
E2	0.057	100%	0.942	7	Accepted
E3	0.060	92%	0.944	4	Accepted
E4	0.060	92%	0.944	4	Accepted
E5	0.087	92%	0.928	11	Accepted

Condition:
Triangular Fuzzy Numbers
1) Threshold Value (d) ≤ 0.2
2) Percentage of experts Consensus > 75%
Defuzzification Process
3) Fuzzy Score (A) ≥ α – cut value = 0.5

Based on the analysis in Table 8. using Fuzzy Delphi Method showing that all the time rejected by the 12 experts. All the three items rejected by the experts with the justification that language translation is less suitable for primary schools' students and also syllabus of language subject. So, this language translation facility rejected by the most experts.

Table 8
Finding of Experts Consensus on language translation facilities

Item	Conditions of Triangular Fuzzy numbers		Conditions of Defuzzification Process	Position	Experts Consensus
	Threshold Value, d	Percentage of Experts Group Consensus, %	Fuzzy Score (A)		
F1	0.665	0%	-	-	Rejected
F2	0.660	8%	-	-	Rejected
F3	0.651	8%	-	-	Rejected

Condition:
Triangular Fuzzy Numbers
1) Threshold Value (d) ≤ 0.2
2) Percentage of experts Consensus > 75%
Defuzzification Process
3) Fuzzy Score (A) ≥ α – cut value = 0.5

Based on the analysis in Table 9. using Fuzzy Delphi Method showing that all the time accepted by the 12 experts. All the items show fuzzy score (A) more than 0.928. In this component expert's emphasis about the function of text synopsis that include in the T2IG application to end user.

Table 9
Finding of Experts Consensus on Text Synopsis Components

Item	Conditions of Triangular Fuzzy numbers		Conditions of Defuzzification Process	Position	Experts Consensus
	Threshold Value, d	Percentage of Experts Group Consensus, %	Fuzzy Score (A)		
G1	0.087	92%	0.928	11	Accepted
G2	0.042	100%	0.950	3	Accepted
G3	0.060	92%	0.944	4	Accepted

Condition:
Triangular Fuzzy Numbers
1) Threshold Value (d) ≤ 0.2
2) Percentage of experts Consensus > 75%
Defuzzification Process
3) Fuzzy Score (A) ≥ α – cut value = 0.5

6. Discussion

This research aims to create a teaching application that will be referred to as T2IG. This application will be able to generate infographics from the text uploaded by students. Therefore, in the phase of getting a consensus from an expert, the Fuzzy Delphi Method is used to carry out the procedure. There was a total of 12 experts contributed to this design phase. The findings showed that the experts accepted six of the proposed components. In total, there were seven proposed components. Twenty-two items were successfully received in this design analysis out of the 25 items listed across the seven components.

As a consequence of this, the component that involves translating texts into a variety of other languages has been dismissed by experts. The majority of involved experts in this study argue that students in primary schools should be exposed to a broad range of linguistic translation topics. Teachers need to be concerned about translation to ensure that the process is carried out in a manner that satisfies the requirements imposed by the structure of the language. Because of this, this study's experts suggested that this application development should emphasize the generation of text that can be loaded into infographics, as mentioned in the research objective. This finding is consistent with the study by Rahman *et al.,* [16], in which it was determined that the content requirements or constructs for module development should consider the low threshold's average value. This finding is in line with those findings. A consensus of 91 percent was reached among the experts in the field

who took part in the study after the FDM analysis that was carried out in two rounds. This method aims to arrive at a decision shared by the majority of people by conducting a series of questionnaires that are answered repeatedly. In the meantime, the research conducted by Raja and Nagasubramani [17] discovered a low average threshold value when determining the components of the provided training resource materials. The investigation that included a total of 13 experts yielded an agreement and consensus rate of 75% regarding the determination of the components of the training set that was provided.

Next, Teräs *et al.,* [18] gathered a sample of field experts consisting of 100 individuals and determined the application of 370 different items in the creation of training instruments. According to the findings, a total of 308 items have been accepted despite having low average threshold values. The FDM analysis, carried out in two rounds, successfully obtained a consensus of 95% from the industry professionals who participated in the study. According to the research findings, 18 training and 44 personality items were eliminated because they did not fulfil the second condition, which stipulated that the percentage of expert consent must be greater than 75%. Further, FDM had details regarding the items eliminated from consideration because they did not fulfil the second condition [4,19]. As a result, there were 148 items for training and 160 items for personality among the remaining items received.

The fuzzy figures of value ratings for each expert were obtained using consensus coefficients. Therefore, one can reach the following conclusion: the findings generated from this technique can help ensure that the development of a T2IG application is accurate. The T2IG application, which can transform the text into an infographic that was developed, includes content and constructs that obtained low threshold average values and high consensus from experts. The study's experts suggested that the T2IG application should emphasize generating text for infographics, which aligns with previous findings emphasizing the importance of considering low threshold average values when developing module content. The FDM analysis, conducted in two rounds, resulted in a 91% consensus among experts. The findings indicate that the FDM technique can help ensure accurate development of the T2IG application, which includes constructs that obtained low threshold average values and high consensus from experts. Overall, the study's findings provide valuable insights into developing a T2IG application that meets expert consensus.

7. Conclusion

This research intends to create an application capable of transforming text input into infographic format. In the meanwhile, twelve experts in technology, language, and education participated in this FDM analysis. Six of the seven components agreed upon by the study's field specialists. Next, 22 articles out of 25 were delivered to experts. The language translation facility component has been rejected by experts on the basis; it is too extensive for the users of this application. They are students in primary school. This design phase has enumerated the essential components that shall serve as the primary functions during the T2IG application development phase. In design analysis employing the FDM strategy or technique, the researcher can precisely determine which components must be used for the T2IG application's primary function.

The implementation of this study has implications for the advancement of knowledge, particularly concerning aspects of practice improvement, and also acts as a guide for policy-making. For example, the findings of this study's design phase, which included the participation of 12 experts, allowed the researcher to develop an instructional application to aid students in writing Malay language subjects. In addition, this study found that teachers are less adept at designing assessment materials for the subjects they teach. Consequently, given these findings, it is essential to accomplish

policy creation incorporating the significance and skills of assessment material development learned in teaching courses.

In addition, as indicated in the problem statement section of this study's findings, there was little variation in the materials utilized by teachers, particularly for assessment activities. As a result, authorities such as the Ministry of Education Malaysia, through the Department and Office of Education, can recommend that teachers generate assessment materials with various assessment activities to improve assessment practices. Teachers might participate in early exposure programs for this reason. In addition, it is conceivable to provide assessment materials with a degree of diversity by incorporating the most technical aspects into reference materials and sources. This component has been incorporated into the development of T2IG applications to the maximum extent possible. Therefore, this application provides a blueprint for subsequent educational applications. As stated by Thomaidis *et al.,* [12], Ocaña-Fernández *et al.,* [20], and Kunter *et al.,* [21] the use of technology in the education becomes a necessity and reform in the educational landscape. The development of this instructional application can aid students in writing Malay language subjects and improve assessment practices. The research recommends incorporating the most technical aspects into reference materials and sources to create assessment materials with a degree of diversity. Finally, the study suggests that technology needs to be integrated into the development of instructional materials to create a technology-friendly educational environment that allows students to be more independent in accessing education.

Acknowledgement
We appreciate the support from FSKIK UPSI in preparing the journal of this article. The authors would also like to thank each individual involved in this research.

References

[1] Al-Qozani, Huda, and Arwa Aleryani. "The impact of IoT on the higher education." *Saba Journal of Information Technology and Networking* 2, no. 2 (2018): 38-48.

[2] Albahri, O. S., A. A. Zaidan, A. S. Albahri, B. B. Zaidan, Karrar Hameed Abdulkareem, Z. T. Al-Qaysi, A. H. Alamoodi et al. "Systematic review of artificial intelligence techniques in the detection and classification of COVID-19 medical images in terms of evaluation and benchmarking: Taxonomy analysis, challenges, future solutions and methodological aspects." *Journal of Infection and Public Health* 13, no. 10 (2020): 1381-1396. https://doi.org/10.1016/j.jiph.2020.06.028

[3] Ayub, E., S. N. A. Mohamad, G. W. Wei, and J. Luaran. "A learning design strategy framework for content transformation using fuzzy delphi method." *International Journal of Information and Education Technology* 10, no. 12 (2020): 882-888. https://doi.org/10.18178/ijiet.2020.10.12.1474

[4] United Nations Educational, Scientific and Cultural Organization. "Artificial intelligence in education: Challenges and opportunities for sustainable development." *Working Papers on Education Policy* 7 (2019).

[5] Suparno, Paul. "Menyikapi penggunaan artificial intelligence (AI, kecerdasan buatan) dalam Pendidikan Fisika." In *Seminar Pendidikan Nasional*, pp. 1-12. 2019.

[6] Chang, Pao-Long, Chiung-Wen Hsu, and Po-Chien Chang. "Fuzzy Delphi method for evaluating hydrogen production technologies." *International Journal of Hydrogen Energy* 36, no. 21 (2011): 14172-14179. https://doi.org/10.1016/j.ijhydene.2011.05.045

[7] Abdullah, Jamelaa Bibi Bt, and S. I. B. M. Yusof. "A Fuzzy Delphi Method-Developing High-Performance Leadership Standard For Malaysian School Leaders." *Journal of Education and Social Sciences* 9, no. 2 (2018): 1-10.

[8] Nur Salina, Ismail, Nor Mazlina, Abu Bakar, and Syed Saadun Tarek Wafa Sharifah Wajihah Wafa. "Online learning challenges during pandemic COVID-19 in Malaysian higher learning institution." *Universal Journal of Educational Research* 8, no. 12 (2020): 7151-7159. https://doi.org/10.13189/ujer.2020.081282

[9] Ministry of Education Malaysia. "Malaysia Education Blueprint 2013 - 2025." *MOE*, 2013.

[10] Mokhtar, Syamsiah, and Ruhizan Muhamad Yasin. "Design of Teaching Influences the Training Transfer Amongst TVET's Instructors: Fuzzy Delphi Technique." *International Journal of Academic Research in Business and Social Sciences* 8, no. 6 (2018): 1083-1097. https://doi.org/10.6007/IJARBSS/v8-i6/4303

[11] Abdullah, Muhammad Ridhuan Tony Lim, Saedah Siraj, and Zaharah Hussin. "Interpretive structural modeling of MLearning curriculum implementation model of english language communication skills for undergraduates." *Turkish Online Journal of Educational Technology-TOJET* 13, no. 1 (2014): 151-161.
[12] Thomaidis, Nikolaos S., Nikitas Nikitakos, and Georgios D. Dounias. "The evaluation of information technology projects: A fuzzy multicriteria decision-making approach." *International Journal of Information Technology & Decision Making* 5, no. 01 (2006): 89-122. https://doi.org/10.1142/S0219622006001897
[13] Goksel, Nil, and Aras Bozkurt. "Artificial intelligence in education: Current insights and future perspectives." In *Handbook of Research on Learning in the Age of Transhumanism*, pp. 224-236. IGI Global, 2019. https://doi.org/10.4018/978-1-5225-8431-5.ch014
[14] Jamil, Mohd Ridhuan Mohd, Shariza Said, and Mohd Ibrahim K. Azeez. "Kompetensi guru terhadap pengurusan pengajaran dan pembelajaran: Suatu pendekatan teknik fuzzy delphi." *JuPiDi: Jurnal Kepimpinan Pendidikan* 1, no. 3 (2017): 77-88.
[15] Omar, Intan Marfarrina, Simah Mamat, Suriati Sulaiman, and Nor Asiah Ismail. "Tahap pengetahuan teknologi, kemahiran dan penggunaan TMK dalam pengajaran dan pemudahcaraan Komsas guru Bahasa Melayu di Kelantan." *JuPiDi: Jurnal Kepimpinan Pendidikan* 8, no. 1 (2021): 47-60.
[16] Rahman, Mohd Nazri Abdul, Mariani Md Nor, Noraziah Ahmad Nadzim, Nor Mashitah Mohd Radzi, and Nurnadia Moktar. "Application of Fuzzy Delphi Approach in Designing Homeschooling Education for Early Childhood Islamic Education." *International Journal of Academic Research in Business and Social Sciences* 6, no. 12 (2016): 2222-6990. https://doi.org/10.6007/IJARBSS/v6-i12/2566
[17] Raja, R., and P. C. Nagasubramani. "Impact of modern technology in education." *Journal of Applied and Advanced Research* 3, no. 1 (2018): 33-35. https://doi.org/10.21839/jaar.2018.v3iS1.165
[18] Teräs, Marko, Juha Suoranta, Hanna Teräs, and Mark Curcher. "Post-Covid-19 education and education technology 'solutionism': A seller's market." *Postdigital Science and Education* 2, no. 3 (2020): 863-878. https://doi.org/10.1007/s42438-020-00164-x
[19] Tsai, Hao-Chang, An-Sheng Lee, Huang-Ning Lee, Chien-Nan Chen, and Yu-Chun Liu. "An application of the fuzzy Delphi method and fuzzy AHP on the discussion of training indicators for the regional competition, Taiwan national skills competition, in the trade of joinery." *Sustainability* 12, no. 10 (2020): 4290. https://doi.org/10.3390/su12104290
[20] Ocaña-Fernández, Yolvi, Luis Alex Valenzuela-Fernández, and Luzmila Lourdes Garro-Aburto. "Artificial Intelligence and Its Implications in Higher Education." *Journal of Educational Psychology-Propositos y Representaciones* 7, no. 2 (2019): 553-568. https://doi.org/10.20511/pyr2019.v7n2.274
[21] Kunter, Mareike, Uta Klusmann, Jürgen Baumert, Dirk Richter, Thamar Voss, and Axinja Hachfeld. "Professional competence of teachers: effects on instructional quality and student development." *Journal of Educational Psychology* 105, no. 3 (2013): 805. https://doi.org/10.1037/a0032583