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"Enhancing English Vocabulary Teaching for Primary School Teachers: Leveraging Fuzzy Delphi Method in Designing Virtual Reality Technology Modules (CoSpaces Edu)"

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Abstract

This study aims to develop a module as teaching material for the English language subject using virtual reality technology. The fuzzy Delphi method was utilized to design and develop this module. Five experts in the fields of English language and technology were selected as the study sample using expert sampling technique. Seven elements were proposed in this study for the purpose of designing and developing this module. These include module introduction, module objectives, module usage guidelines, virtual reality technology, general guidelines for CoSpaces Edu, guidelines for using virtual reality materials (CoSpaces Edu), and guidelines for developing VR technology materials (CoSpaces Edu). The seven proposed elements were agreed upon by the experts with a threshold value (d) of less than 0.2, expert agreement percentage on any item exceeding 75%, and fuzzy score > 0.500. Thus, the findings indicate that the seven proposed elements in module development were agreed upon by the experts. The utilization of the fuzzy Delphi method in designing and developing virtual reality technology modules for English language teaching has been validated through expert consensus. This approach ensures that the module meets the criteria set forth by experts in both language education and technology, suggesting its potential effectiveness in enhancing English language learning outcomes in elementary school settings.

Keywords: Virtual Reality, English Vocabulary, Fuzzy Delphi Method, Technology Module

Introduction

English language learning becomes crucial for students after the Malaysian Ministry of Education standardized language education policy. The Second Shift of the Malaysia Education Development Plan (PPPM) 2013-2025 emphasizes mastery of language skills, including listening, speaking, reading, and writing, by all students to achieve the nation's aspirations and provide a foundation for academic excellence. The importance of learning English as a second language has been emphasized in Malaysia so that students can read and understand various English texts. Vocabulary forms the basis of language skill mastery in English language learning. In the learning of any language, vocabulary is the first and crucial knowledge to be

taught. In the Primary School Standard Curriculum (KSSR) policy, mastery of English vocabulary is also crucial to enable students to communicate and achieve proficiency in the language.

The Chairman of Yayasan Pintar, Arshad Ayub, has also stated that many Malaysian students fail to master the English language due to a lack of interest in learning it. The decline in students' interest in learning English and their lack of adequate vocabulary highlights the need to explore technologies that can be used in English language teaching and facilitation in the Malaysian education system. Therefore, teachers can deliver PdPc methods in an engaging manner that aligns with the era of information and communication technology. Integrating technology with pedagogy and subject content is a major challenge for teachers in integrating technology during PdPc. Hence, this study will focus on the development of virtual reality technology modules to assist teachers in teaching English vocabulary. These modules will serve as a reference for teachers in using and developing VR technology in accordance with their pedagogical content. Several past studies have focused on module development, including integrated teaching modules for the Malay language Fong et al (2022) and the development and evaluation of Interactive Virtual Reality Modules for Music Appreciation in Secondary Schools (e-MARZ) (Saidon et al., 2021).

In English Language Teaching (ELT), learning and mastering vocabulary play a crucial role as it helps students to construct correct sentences and facilitate communication. A wide range of English vocabulary usage can enhance students' ability to communicate in the language Puntadewi & Engliana (2018) stated that "vocabulary is central to language and of critical importance to the typical language learner." This indicates that mastering vocabulary plays a vital role in word recognition. Halimah and Rachmijati (2019) argue that the more English vocabulary a student masters, the better they can grasp the subject matter being presented. Recognizing the importance of mastering vocabulary in the English language subject, English teachers should diversify their teaching strategies by incorporating technological elements to meet the needs and preferences of students who are more inclined towards technology-based learning methods. When technology is used appropriately, it offers many advantages to both teachers and students (Ahmadi, 2018).

Technology is utilized in education to facilitate the teaching and facilitation process (PdPc). Technology is believed to assist in the learning process, and Malaysia is one of the countries that has embraced it. The use of technology can encourage the development of educational policies that promote a creative and innovative educational institution environment (Maatuk et al., 2022).

E-learning is one of the learning methods that utilizes technology. This e-learning method is implemented using personal computers and internet networks. The internet requirement is crucial in using this e-learning method to facilitate educators and students to interact online or disseminate information widely. Rader and Wilhelm (2001) stated that this method allows students to obtain desired information in learning more systematically.

Furthermore, virtual reality (VR) technology offers a three-dimensional virtual environment and more effective interaction systems, enhancing motivation in the learning process. VR technology can be used to support education and improve the quality of student learning. For instance, the application of VR technology can be used in the language learning process.

Current researchers believe that virtual reality is an interactive experience based on 3D avatars, generated by computers, its simulation generated by computers, and it is about the real world or just imagination (Piovesan, Passerino & Pereira, 2012).

The current and future needs become imperative to utilize the latest technology in the education process. One relatively new solution that is still underutilized is virtual reality (VR) technology. According to Serin (2020), most teachers find virtual reality to be engaging, encouraging students to become active, suitable for students with schematic and visual thinking styles, providing students with a general idea of the subject, facilitating information implementation, and making it easier to learn.

Objective and Significance

So, this study focused on identified answers for objectives and research questions as mentioned in table 1.

Table 1

Research Objective with Its Significance

Research Objective	Research Questions
1. To develop virtual reality technology modules aimed at enhancing English vocabulary teaching for elementary school teachers in Malaysia.	1. What are the key components and features to be included in the virtual reality technology modules designed for teaching English vocabulary to elementary school students?
2. To evaluate the effectiveness of the developed virtual reality technology modules in improving students' English vocabulary acquisition and retention in elementary school settings.	2. How do elementary school teachers perceive the usability, feasibility, and effectiveness of the virtual reality technology modules in facilitating English vocabulary teaching and learning?

Material and Method

A) Design of Study

Researchers utilize the Fuzzy Delphi Method (FDM) to identify and validate elements to be included in the module to be developed based on expert consensus. The Traditional Delphi Method is widely used in planning and forecasting Cheng & Lin (2002); Jones & Twiss (1978) to obtain convergence of opinions from a group of experts regarding specific real-world issues (Hsu & Sandford, 2007). This method was originally developed and implemented by the RAND Corporation in the 1950s and 1960s (Ziglio, 1996). Initially, this method was deliberately created for military and political purposes (Deslandes, Mendes, Pires, & Campos, 2010). In modern research, the Delphi Method is used in various types of studies such as quantitative simulation models, in-depth interviews, and group meetings, while in the digital era, some researchers conduct online surveys to avoid delays and reduce burdens (Gordon, 2003). According to Powell (2003), the Delphi Method is a flexible approach to achieving expert consensus.

B) Sampling Method

The selection of expert panels for the validation process is crucial to ensure that the suggestions and comments from experts align with the requirements of the research field.

Therefore, researchers first seek approval from these experts before appointing them as expert panels. Subsequently, the expert panel will validate the elements of the VR Technology module to be developed in the design and development phase. A total of five experts are appointed for the purpose of validating the module elements to be developed. The appointed experts consist of one SISC+ English Language Specialist, two outstanding English language teachers, and two technology experts with more than 10 years of expertise and experience. The criteria and characteristics of the experts match the research context as it involves experts in computer science, technology, and education. Expert selection is also guided by Berliner (2004), who states that an expert is someone consistently involved in a field for more than five years. All selected experts are non-uniform in nature. Therefore, the sample size chosen is appropriate, as Clayton (1997) suggests that the appropriate sample size for non-uniform experts is between 5 to 10 individuals.

C) Research Instrument

In this design phase, a questionnaire is utilized as the instrument to obtain consensus data on the elements of Virtual Reality Technology module for English Vocabulary Teaching for elementary school teachers. The use of the questionnaire is to meet the criteria and requirements of using the FDM method, which involves the use of specific formulas to obtain expert consensus (Saedah, 2008).

The researchers adapted the format of the questionnaire instrument used by (Khairul, 2020). The format of the questionnaire instrument will be modified based on the requirements of this phase. The researchers will use literature review and analysis findings of needs assessment phase to develop the module. The questionnaire is divided into two parts, namely Part A, B, and C. Part A discusses the demographics of the respondents, which are the experts, while Part B discusses the arrangement of elements in the module to be developed later. Part C will contain the elements in the development of the module for teaching English vocabulary. In the final part of the questionnaire, the researchers will provide a comment section to obtain feedback from the experts. In the use of the Fuzzy Delphi technique for a study, there are steps that need to be followed to ensure that this study is considered empirical.

D) Research Findings

In this phase, a total of five experts have been identified and involved. All five research experts have qualifications in English language and information technology. According to Table 1, all five research respondents are male, and all research experts have experience in the field of at least 10 years and above. From the group of research experts, two are outstanding English language teachers, one is an SISC+ officer, and two are information technology officers.

Among the research expert organizations are schools, District Education Offices, and the Education Technology Resources Division. The selection of research experts is based on the expertise possessed by each respondent. All five research experts have extensive knowledge and experience in the field of information technology and English language. The following is Table 1, which provides detailed demographic information of the research experts:

Table 2
Respondent Profile

Expert	Position	Organization	Gender	Field	Experience
E1	SISC+ officer	PPD	Male	English	30 years
E2	Excellent Teacher	School	Male	English	15 years
E3	Excellent Teacher	School	Female	English	12 years
E4	Technology officer	PPD	Male	Infomation Technology	15 years
E5	Technology officer	PPD	Lelaki	nfomation Technology	20 years

In order to identify the consensus of the research experts for the introduction component of the module, four items were tested. Based on Table 3, it was found that as many as four items have been agreed upon by five experts. The threshold value (d) for each item is recorded between 0.095 and 0.087. This shows that the condition has been met because the threshold value (d) for the construct is ≤ 0.2. Next, the fuzzy score for four items is also ≥ 0.5 which is 0.919 for the first and second items while 0.928 for the third and fourth items. Therefore, all items listed under the module identification component are accepted. Meanwhile, the percentage of expert group agreement for four items was 92%. So, this further reinforces that this component should be taken into account in the module design where the basic requirement is > 75%. The findings obtained from the fuzzy Delphi show that the identification component of the module with these four items was unanimously accepted by five research experts.

Table 3
Fuzzy Delphi (Modul Introduction Component)

Items / Element	Terms of Triangular Fuzzy Numbers		Terms of Defuzzification Process				Expert Consensus
	Threshold, d	Percentage of Expert Group Agreement	m_1	m_2	m_3	*Fuzzy score (A)*	
1	0.095	92%	0.817	0.950	0.992	0.919	**Accept**
2	0.095	92%	0.817	0.950	0.992	0.919	**Accept**
3	0.087	92%	0.833	0.958	0.992	0.928	**Accept**
4	0.087	92%	0.833	0.958	0.992	0.928	**Accept**

In order to identify consensus from research experts for the general guidance component of CoSpaces Edu, five items were tested. Based on Table 4.19, it was found that as many as five items have been agreed upon by five experts. The threshold value (d) for each item is recorded between 0.023 and 0.095. This shows that the condition has been met because the threshold value (d) for the construct is ≤ 0.2. Therefore, all items listed under the CoSpaces Edu general guidance component are accepted. Meanwhile, the percentage of expert group agreement for all five items was 100% for the first and second items while 92% for the third, fourth and fifth items. So, this further reinforces that this component should be taken into account in the module design where the basic requirement is > 75%. Next, the fuzzy score for all three items

is also ≥ 0.5 which is 0.958 for the first item, 0.942 for the second item, 0.944 for the third item and the fourth item. The findings obtained from the fuzzy Delphi show that the general guidance component of CoSpaces Edu with these five items was unanimously accepted by five research experts.

Table 4
Fuzzy Delphi (CoSpaces Edu Component)

Items / Element	S Terms of Triangular Fuzzy Numbers		Terms of Defuzzification Process				Expert Consensus
	Threshold, d	Peratus Kesepakatan Kumpulan Pakar	m_1	m_2	m_3	*Fuzzy score (A)*	
1	0.023	100%	0.883	0.992	1.000	0.958	**Accept**
2	0.057	100%	0.850	0.975	1.000	0.942	**Accept**
3	0.060	92%	0.867	0.975	0.992	0.944	**Accept**
4	0.060	92%	0.867	0.975	0.992	0.944	**Accept**
5	0.087	92%	0.833	0.958	0.992	0.928	**Accept**

The results of the fuzzy delphi method show that seven of the proposed components (constructs) have been accepted by five research experts. The following is a summary of the findings of the fuzzy delphi method process where module development focuses on the seven recommended components.

Table 5
Summary of Fuzzy Delphi Analysis Findings

Main Construct	*Defuzzification*			Overall Average Threshold Value, d (d ≤ 0.2)	*Fuzzy Score (A)*	Consensus
	m_1	m_2	m_3			
Module Introduction	0.919	0.919	0.928	92%	**0.922**	**Accept**
Module Objectives	0.933	0.928	0.936	94%	**0.932**	**Accept**
Module Usage Guide	0.914	0.928	0.936	88%	**0.925**	**Accept**
Virtual Reality Technology	0.958	0.919	0.928	94%	**0.933**	**Accept**
CoSpaces Edu General Guide	0.958	0.942	0.944	95%	**0.943**	**Accept**
Guide to using virtual reality materials (CoSpaces Edu)	0.933	0.928	0.936	94%	**0.925**	**Accept**
VR technology material development guide (CoSpaces Edu)	0.928	0.950	0.944	94%	**0.914**	**Accept**

As shown in Table 5, as many as seven components (constructs) were accepted and got consensus from five research experts. In conclusion, the consensus among experts on the components of the educational module underscores the critical importance of each element in creating an effective and comprehensive learning tool. The unanimous agreement on the inclusion of specific introductory and guidance components highlights the necessity of clear, structured educational resources. The Module Introduction provides a clear overview and sets the context for learners, ensuring they understand the scope and relevance of the module. Similarly, the Module Objectives clearly outline the learning goals, helping learners to focus on the desired outcomes and understand what they are expected to achieve.

Additionally, the Module Usage Guide offers detailed instructions on how to navigate and utilize the module, ensuring that users can efficiently access and engage with the content. Integrating Virtual Reality Technology further enhances the learning experience by providing immersive and interactive educational opportunities. The CoSpaces Edu General Guide serves as a comprehensive manual for using the CoSpaces Edu platform, facilitating seamless integration and utilization of virtual reality in educational settings.

Moreover, the Guide to Using Virtual Reality Materials (CoSpaces Edu) provides specific instructions on effectively using virtual reality materials, ensuring that learners can maximize the benefits of this technology. Finally, the VR Technology Material Development Guide (CoSpaces Edu) offers a step-by-step guide for developing virtual reality content, empowering educators and instructional designers to create high-quality, engaging educational materials.

The unanimous agreement on these components underscores the necessity of clear, structured, and technologically advanced educational resources. This consensus highlights the critical role of interdisciplinary collaboration and expert input in developing modules that are not only informative but also engaging and user-friendly. By incorporating these components, future educational module development can be significantly enhanced, leading to improved learning outcomes and a richer educational experience.

Discussion

The findings of this study align with previous research that emphasizes the importance of interdisciplinary expertise in educational module development. The inclusion of experts with qualifications in both English language and information technology highlights the growing trend of integrating diverse fields to enhance educational outcomes. Previous studies, such as Amrullah and Nanzah (2022), have demonstrated that interdisciplinary approaches foster a more comprehensive understanding of educational content, thereby improving the efficacy of educational modules.

In this study, the selection of experts based on their extensive experience and diverse professional backgrounds ensured a well-rounded perspective in the module development process. This mirrors the findings of earlier research by Akgun and Greenhow (2022), which underscore the value of diverse expertise in achieving consensus on educational content. The high threshold values and fuzzy scores reported in this study reflect a robust agreement among the experts, reinforcing the validity of the selected components. This is consistent with the conclusions drawn by Alobaid (2020), who found that high levels of expert agreement are indicative of reliable and effective educational frameworks.

The unanimous acceptance of the introduction component and the general guidance component of CoSpaces Edu by the experts underscores the critical role of foundational and guidance elements in educational modules. The findings are in line with those of Amani et al (2021), who emphasized that clear introductory and guidance components are essential for the successful implementation of educational technologies. The high percentage of agreement and the exceeding of the basic requirement of 75% further validate the inclusion of these components, highlighting their importance in creating a coherent and user-friendly module.

Moreover, the study's use of the fuzzy Delphi method to achieve consensus among experts is supported by previous literature. Amiruddin et al (2023) highlights the effectiveness of the Delphi method in gathering expert opinions and achieving consensus in complex decision-making processes. The successful application of this method in the current study demonstrates its utility in educational research, particularly in the development of interdisciplinary modules.

In conclusion, the findings of this study are well-supported by previous research and provide a solid justification for the inclusion of the identified components in the educational module. The integration of expertise from both English language education and information technology, the rigorous selection of experts, and the robust consensus achieved through the fuzzy Delphi method all contribute to the development of a comprehensive and effective educational module. This study adds to the growing body of literature that supports interdisciplinary approaches and consensus-driven methodologies in educational research and module development.

Implication

The findings of this study have several significant implications for the development of educational modules, particularly in the context of interdisciplinary integration and the use of consensus-driven methodologies. Firstly, the successful inclusion of experts with qualifications in both English language and information technology underscores the necessity of interdisciplinary approaches in educational design. Baharudin et al (2020) stated integrating diverse fields can lead to more comprehensive and effective educational tools. This implies that future module development should actively seek to incorporate expertise from multiple disciplines to address the multifaceted nature of education in the digital age.

Furthermore, the rigorous selection of experts based on extensive experience and diverse professional backgrounds highlights the importance of leveraging diverse perspectives in educational research. This approach, validated by the work of Bakla (2019), suggests that educational institutions and policymakers should prioritize the involvement of professionals with varied expertise when designing curricula and educational technologies. Such diversity can enhance the quality and relevance of educational materials, ensuring they meet the needs of a broad spectrum of learners.

The study also reinforces the value of clear introductory and guidance components in educational modules. The high levels of expert agreement on these components, as well as their validation through fuzzy Delphi methodology, align with the findings of Brill et al (2020), who emphasized the necessity of clear structure and guidance in educational resources. This

implies that educators and instructional designers should focus on developing robust introductory and guidance sections within educational tools to facilitate ease of use and improve learning outcomes.

The use of the fuzzy Delphi method in this study demonstrates its effectiveness in achieving expert consensus and validates its application in educational research. As Briones-Bitar et al (2020) have shown, the Delphi method is a powerful tool for gathering and synthesizing expert opinions in complex decision-making scenarios. This suggests that future research in educational module development could benefit from employing the fuzzy Delphi method to ensure the reliability and validity of research findings. By doing so, researchers can achieve a higher degree of consensus among experts, leading to more robust and universally accepted educational frameworks.

In conclusion, the implications of this study suggest that educational module development can be significantly enhanced by interdisciplinary collaboration, the involvement of diverse experts, the inclusion of clear guidance components, and the use of consensus-driven methodologies like the fuzzy Delphi method. These practices not only improve the quality and effectiveness of educational tools but also align with current trends and findings in educational research, thereby providing a solid foundation for future innovations in the field.

Conclusion

In conclusion, this study highlights the critical importance of interdisciplinary expertise and consensus-driven methodologies in the development of educational modules. The integration of professionals with extensive backgrounds in both English language and information technology has proven to be a pivotal factor in creating comprehensive and effective educational tools. The unanimous agreement among experts on the inclusion of specific introductory and guidance components underscores the necessity of clear and structured educational resources, which facilitate better learning outcomes.

The study's methodology, particularly the use of the fuzzy Delphi method, has been validated as an effective approach to achieving expert consensus. This reinforces the importance of employing rigorous and systematic processes in educational research to ensure the reliability and validity of findings. The implications drawn from this study suggest that future educational module development should prioritize interdisciplinary collaboration, diverse expertise, and clear guidance to enhance the quality and usability of educational materials.

Overall, the findings and implications of this study provide a strong foundation for future research and development in educational technologies. By adopting these practices, educators, instructional designers, and policymakers can create more effective and user-friendly educational tools that meet the diverse needs of learners in a rapidly evolving educational landscape. This study contributes to the growing body of literature advocating for interdisciplinary approaches and robust consensus methodologies in the field of education, paving the way for future innovations and improvements in educational practice and research.

Contribution

This study's contributions to educational research and module development are multifaceted, reflecting the critical insights gained through an interdisciplinary and consensus-driven

approach. By integrating expertise from both the English language and information technology, the study demonstrates the value of multidisciplinary collaboration in enhancing the quality and effectiveness of educational tools. This integration provides a richer, more comprehensive perspective on module content and ensures that the materials are both pedagogically sound and technologically advanced. This contribution is significant as it offers a model for future educational initiatives to follow, highlighting the benefits of drawing on diverse fields of expertise.

Additionally, the study's rigorous selection of experts and the successful application of the fuzzy Delphi method underscore the importance of methodological rigor in educational research. The consensus achieved among experts on key components of the educational module validates the reliability of the findings and provides a solid foundation for future module development. This methodological contribution is particularly important in educational research, where achieving a high degree of reliability and validity is crucial for the adoption and implementation of new educational tools and practices. The study exemplifies how structured and systematic approaches can lead to more robust and widely accepted educational frameworks.

In summary, the contributions of this study are both theoretical and contextual, offering valuable insights and methodologies that can be applied in the development of educational modules. Theoretically, it advocates for interdisciplinary collaboration, rigorous methodological approaches, and the incorporation of expert consensus in educational research. Contextually, it provides practical guidance on the creation and implementation of educational tools, emphasizing the inclusion of clear guidance components and advanced technologies like virtual reality. These contributions are poised to have a lasting impact on the field, guiding future research and development efforts in educational technology and instructional design. By presenting a comprehensive framework for improving educational tools, this study sets a precedent for future innovations and improvements in educational practice and research.

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