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The Essential Technology Implementations for Developing a Hybrid Module for High School Physics in the Sultanate of Oman

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Physics is commonly perceived as a challenging academic discipline, with a contributing factor being the limited availability of educational resources to support students. Consequently, there arises a need to develop a module focused on the incorporation of technology in physics education. The integration of technology within pedagogical modules refers to the practice of including various technological Implementations in educational content. This study aimed to investigate and rank the most efficient technological implementations for designing a pedagogical hybrid physics module for students in grades 9-12 in the Sultanate of Oman. A literature review was conducted concerning the integration of technology in hybrid learning and physics education. Qualitative and quantitative research methodologies were employed for data collection, the data were analyzed utilizing Fuzzy Delphi Method (FDM). To establish the FD instrument, a panel of six experts was consulted through semi-structured interviews. This panel identified 13 significant technology Implementations for the development of the module. Subsequently, a group of 12 experts was surveyed to identify the essential technology Implementations. Consequently, four technology Implementations were excluded, while the accepted Implementations were then prioritized using FDM. The findings revealed that Mobile instant messaging claimed the top position, with Artificial Intelligence (AI) ranking at the lowest position.

Keywords: Fuzzy Delphi Method, FDM, hybrid learning, module development, teaching physics, technology Implementations

INTRODUCTION

Teaching physics through instructional technology is a dynamic and effective approach that enhances the learning experience for both students and educators. This modern pedagogical method harnesses the power of digital tools and resources to impart physics concepts engagingly and interactively. Hazari et al. (2010), revealed the majority of students initially notice the distinct differences between physics and other disciplines in secondary school. Accordingly, secondary school is the first opportunity for students to

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become actively involved in physics and the period during which teachers and learning environments can have a big impact on students' attitudes toward the subject. Research indicates that science schools, including those focusing on physics, predominantly employ a transmissive approach, which entails rote memorization of physics equations, principles, and laws, along with the completion of routine practice exercises. This instructional method is characterized as dull and unengaging for students, lacks the stimulation of critical thinking, and falls short of aligning with both current societal expectations and modern physics curriculum standards, as highlighted by Dagher and BouJaoude (2011). Therefore, developing a technology-based module may captivate students and foster their physics learning in the age of the fourth industrial revolution. A learning module is a self-contained, structured learning experience with defined learning outcomes and assessment criteria (Dick & Carey, 2001). The main components of a module include learning objectives, outcomes, resources, teaching methods, assessment criteria, and evaluation. A hybrid learning module is an educational approach that combines elements of both traditional face-to-face classroom instruction and online learning (Graham, 2013). Integrating technology into a physics hybrid learning module can offer the significance of enhancing engagement, flexibility, and personalization, as well as aligning education with the evolving demands of the modern workforce.

The COVID-19 pandemic has accelerated the integration of technology into physics hybrid learning, emphasizing the need for flexible and adaptable teaching methods. It has also highlighted the importance of digital resources, connectivity, and professional development for educators. The changes brought about by the pandemic are likely to have a lasting impact on the way physics education is delivered and will continue to shape the future of instructional technology in this field. While the COVID-19 pandemic impacted individuals across diverse backgrounds, teachers and students promptly resumed their studies by establishing emergency remote learning systems (Selvaraj et al., 2021).

Post the COVID-19 pandemic, the Sultanate of Oman, as with many other countries, adopted online and hybrid learning approaches to keep school continuity while putting student and teacher safety first. According to research by Mufida et al. (2021), adopting virtual laboratories and e-modules in physics teaching during the COVID-19 epidemic had a significant impact on student performance. These online resources were especially important for high school students, providing them with many methods to practice their physics problem-solving skills during a critical time. The educational system in the Sultanate of Oman is highly organized. Basic education is divided into two cycles: cycle one covers grades 1-4, while cycle two covers grades 5–10. Grades 11 and 12 make up the two years of post-basic education (Al-Balushi et al., 2014). Basic science is taught in Oman's basic school curriculum in its initial phases (Al-Abri, 2010). From grades one through eight, physics is covered in the science curriculum. From grades nine and ten, physics is taught as a stand-alone subject that all students must take. Thereafter, students can choose physics as an elective in grades eleven and twelve. Developing the education system is a top preference for the Omani government to regulate with Oman's Vision 2040. Furthermore, the utility of technology as a learning resource has the power to significantly impact learning activities, alter the teaching process, and improve student learning in Oman (Al-Amri et al., 2020). However, there are still several challenges that educators must take to successfully merge online and hybrid learning in Omani schools. Additionally, students in the Sultanate of Oman struggle with different subjects, with science being a marked concern. According to national and international assessments managed in Oman, student accomplishment does not meet government goals, especially when it comes to science (Al-Amri et al., 2020). Though little study has been conducted in this area, it is valuable to use instructional technologies when teaching school physics in Omani schools. Al-Balushi (2016) suggested that one way to overcome the challenges facing scientific education research in Oman is to increase the number of studies conducted in this area. To support the Sultanate of Oman's future scientific graduates meet the requirements of the global economy, Ambusaidi et al. (2022) underline the importance of making extra efforts to teach them 21st-century capabilities. This can be achieved by featuring the development of technology in science hybrid learning which can have a massive impact on student achievement in Oman. Shaping technology into physics learning modules may meet the up-to-date needs of learners in a rapidly evolving, technology-driven world and reinforce education quality. Collaborative mobile Learning Science Module in a Malaysian Secondary School on nutrition in science has been developed with five online lessons, an initial face-to-face module orientation meeting, and a final face-to-face meeting to make up the module (DeWitt et al., 2013). According to the results, learners interacted with the content, teacher, and other learners in the discussion forum by which the internet communication technologies encourage collaboration and are beneficial in science education. Therefore, there is a demand for developing a pedagogical physics hybrid learning for students in grades (9-12) in the Sultanate of Oman by incorporating technology. The primary objective of this study is to investigate the essential technology implementations for developing a hybrid physics module for students in grades (9-12) in the Sultanate of Oman. In this study, the Fuzzy Delphi Method (FDM) was employed to carry out three primary stages. The FD instrument was created and shared with a panel of 12 experts to establish a consensus regarding the technological components to incorporate into the module. The data collected were subsequently analyzed using FDM (Chang et al., 2011). To be specific, the objectives of this study are:

1. To identify the implementations of technology for developing a pedagogical physics hybrid module for students in grades (9-12) in the Sultanate of Oman according to experts' opinion.

2. To determine the essential technology implementations for developing a pedagogical physics hybrid module for students in grades (9-12) in the Sultanate of Oman according to experts' consensus.

3. To prioritize the essential technology implementations for developing a pedagogical physics hybrid module for students in grades (9-12) in the Sultanate of Oman according to experts' consensus.

Building upon the previous research objectives, the research questions for developing a technology-based hybrid module for teaching school physics in the Sultanate of Oman by implementing the Fuzzy Delphi Method FDM, are:

1. What are the implementations of technology for developing a pedagogical physics hybrid module for students in grades (9-12) in the Sultanate of Oman according to experts' opinions?
2. As established by expert consensus, which technology implementations are essential for developing a pedagogical hybrid physics module tailored for students in grades 9-12 in the Sultanate of Oman?
3. According to expert consensus, which essential technology implementations should be prioritized in the development of a pedagogical physics hybrid module for grade (9-12) students in the Sultanate of Oman?

Literature Review

Integrating Technology within Hybrid Learning

The process of building Hybrid Learning or Blended Learning, which comprises two learning environments, namely online learning, and classroom instruction (Graham, 2013). Hybrid learning offers the advantage of combining practical, hands-on learning with self-directed, motivated learning. In a Hybrid learning curriculum, students gain firsthand experience with the material and become more responsible for their education (Seage & Türegün, 2020). Integrating technology within hybrid learning has the significance of enhancing flexibility, personalization, and accessibility in education. It empowers both educators and students to engage with content in innovative ways, promotes active learning, and provides valuable data for continuous improvement. This approach also aligns with the evolving demands of the modern workforce, making it a significant and forward-looking educational strategy. The developing field of online instruction should be considered and incorporated into every educational plan (Penprase, 2018). The Fourth Industrial Revolution has brought about a parallel evolution in educational technologies, these days, a wide range of synchronous and asynchronous educational resources and technology tools. A notable example of a novel learning environment is the synchronous hybrid or blended learning arena, accommodating both on-site and remote students attending learning activities simultaneously (Raes et al., 2020). Video Conferencing Tools like Zoom, and Microsoft Teams, enable synchronous online classes, meetings, and collaboration. Because synchronous hybrid learning is a recent development, many educational institutions are dedicating resources to technology-empowered learning environments. This prompts an inquiry into optimizing the effectiveness of these settings. Integrating different technology implementations when developing a hybrid teaching module is vital. It accommodates diverse learning styles and preferences, keeping students engaged and fostering comprehensive understanding. Technology implementations and tools are indispensable for enhancing the effectiveness and efficiency of hybrid learning, making it more interactive, adaptable, and accessible. For instance, digital projectors are one of the most favored technologies for educational purposes (Hill & Valdez-Garcia, 2020). It is a valuable tool for teaching in a hybrid learning context. It enhances visual engagement by projecting content, such as slides and videos, on a large screen for both in-person and remote students. Mobile-based learning is also well-suited for teaching in a hybrid learning environment. Lim and Kamin (2023) discovered a requirement for creating a mobile-oriented educational module that includes specified user interface designs and usability standards. It offers accessibility, flexibility, and engagement, as students can access materials, collaborate, and complete assignments on their mobile devices. These devices support interactive, personalized learning, fostering real-time updates and facilitating assessments. Mobile apps can reduce costs and enhance the learning experience by providing immediate feedback. Furthermore, all businesses including education have been affected by the Internet of Things, Artificial Intelligence (AI), and automation, which has resulted in a shift in employee skill requirements (Techanamurthy et al., 2020). Hill and his colleagues (2015) developed hybrid learning modules in response to the increasing volume of information for students to absorb and the expanding variety of students, which has put a demand on practitioners to discover other ways of teaching science topics. Technology Implementations improve engagement, flexibility, and data-driven insights, making physics education more accessible, personalized, and efficient. Additionally, they reduce costs, support sustainability, and adapt to modern educational needs. Future students must be prepared to quickly adapt to Industry 4.0.

Technology Implementations for Physics Education

Implementing Technology in physics education can enhance the learning experience by providing tools for visualization, experimentation, accessibility, and personalization. These advancements make physics education more engaging, practical, and inclusive, helping students develop a deeper understanding of the subject and prepare for careers in various fields that require physics knowledge. Utilizing technology in teaching physics can render the educational process more captivating, responsive, and efficient. Integrating technology with hybrid learning significantly boosts students' success in comprehending physics, as indicated by Sivakumar et al. (2019). This approach corresponds to the changing demands of students, fostering the acquisition of skills pertinent to the contemporary, technology-driven society. Ramma et al. (2018) identified a favorable connection between technology utilization and the teaching of physics. Hill and associates (2015) observed that the incorporation of online learning modules in a physics course led to improved performance in both conceptual understanding and representational reasoning assessments. Alias et al. (2013) ascertained the advantages of developing a technology-integrated physics module in a secondary school setting. Moreover, Herayanti et al. (2020) established a robust relationship between the implementation of inquiry-based hybrid learning and the academic success of physics students. Hybrid learning can serve as a viable alternative approach to assist students in addressing challenges in physics education (Syafril et al., 2021). It is an innovative approach, that integrates in-person and online instruction and can be effectively employed in teaching Physics to boost the academic outcomes and knowledge retention of high school students (Sivakumar & Selvakumar, 2019). Currently, physics teachers are strongly required to adjust by creating digital teaching resources and employing technological Implementations. Using blogs, for instance, can provide a flexible and accessible platform for teaching and learning, offering opportunities for creativity, critical thinking, and communication in educational contexts (Garcia et al., 2019). Students do indeed recognize increased levels of learning when utilizing blogs. However, the acknowledged advantages of blog usage are shaped by students' attitudes toward the integration of technology in education, their perception of the usefulness of blogs, and their prior experience with blog usage. Thohir et al. (2020) showed the advantages of blog transformation for physics learning sessions and solving real-world problems. Arista & Kuswanto (2018) discovered employing an Android-based Virtual Physics Lab enhanced self-reliance and conceptual comprehension in learning. In addition, incorporating augmented reality (AR) into physics instruction not only elevated students' academic performance but also fostered a favorable outlook on physics topics. It plays a crucial role in ensuring that students retain their grasp of physics concepts over the long term (Fidan & Tuncel, 2019). Furthermore, Budi et al. (2021) researched the application of Virtual Reality (VR) Technology in the context of Physics Learning. Students' perceptions of this technology, particularly concerning their self-confidence, and overall experience, including satisfaction, motivation, and engagement, were positive. Moreover, Twitter plays a part in enhancing students' learning capabilities and enhancing their motivation and involvement through its unique features and unconventional educational approach, as emphasized by Malik et al. (2019). Science teachers cultivate a positive tone in their Twitter interactions, thus fostering a nurturing atmosphere for professional development that could potentially alleviate the sense of professional isolation (Fischer et al., 2019). Simulations and virtual labs offer hands-on experience without physical equipment. Prasetya et al. (2022) concluded that student's motivation to learn increased as a result of utilizing PhET Simulations in an online physics course. As evolution continues, adjustments must be made to guarantee that physics students' knowledge and abilities align with the instructional technology.

METHOD

The research process aimed at selecting suitable technology implementations for the development of a physics hybrid module involved a comprehensive blend of qualitative and quantitative methodologies, facilitated by a carefully selected group of experts. These experts were chosen based on specific criteria to ensure their ability to provide valuable insights and opinions relevant to the development of a hybrid physics module tailored for students in grades 9 to 12 in the Sultanate of Oman. The selection of experts was meticulously carried out, considering their extensive experience in teaching and learning physics, as well as their proficiency in instructional technology. Each expert possessed over a decade of expertise in their respective fields, establishing them as highly qualified individuals capable of contributing significantly to the subject matter. The research unfolded through a systematic sequence of three main stages, adhering to a methodical approach outlined by Mohamad et al. (2015) for the execution of such phases. The initial phase commenced with qualitative exploration conducted through semi-structured interviews. These interviews were meticulously designed to elicit in-depth insights and perspectives from the selected experts. Through a series of structured discussions, the experts provided valuable input, which served as the foundation for the development of the Fuzzy Delphi (FD) instrument. This phase facilitated a nuanced understanding of the requirements and preferences for the hybrid module's technology implementations. Following the qualitative exploration, the research progressed to the quantitative phase, which involved the distribution of the FD instrument via an e-questionnaire. The questionnaire was meticulously designed, based on the perceptions collected from the qualitative interviews, the questionnaire was meticulously designed. The FD instrument covered a larger number of participants, thereby improving the diversity and comprehensiveness of the data obtained by employing electronic distribution approaches. This stage aimed to develop a solid dataset for subsequent research by quantifying and validating the qualitative results. While the last phase centered on data analysis, by adopting the Fuzzy Delphi Method (FDM) to synthesize and systematically analyze the gathered data. The answers to the questions from the qualitative interview and the quantitative questionnaire iteratively were evaluated by the study team using FDM. This approach facilitated the identification of aspects of divergence and consensus among the experts, ultimately guiding the selection of technology implementations for the physics hybrid module. The reliability and validity of the study results were guaranteed by the rigorous data analysis procedure.

First Phase: Developing the Fuzzy Delphi (FD) Instrument

The phrase "FD instrument" in the context of the Fuzzy Delphi Method often refers to the instrument or tool that is used to conduct the Fuzzy Delphi process. Stated otherwise, the Fuzzy Delphi Method's FD instrument in the Fuzzy Delphi Method is the mechanism through which experts convey their opinions, and it's made to manage and analyze the fuzzily provided data. Six experts were engaged in a semi-structured interview to develop the FD Instrument for this study, following the interview protocol as outlined by Creswell (2002). During the interview, experts were consulted over the essential technology implementations to be utilized in creating a hybrid physics module for students in grades 9 through 12. Furthermore, their perspectives were requested regarding the most optimal electronic platform for this module's delivery. The software Atlas.ti 7 for qualitative data analysis was utilized to code the data from the qualitative interviews. Thematic analysis, as described by Braun and Clarke in 2006, was used to classify the emerging themes of technology implementations from the expert interviews, which were instrumental in the development of the FD Instrument. An overview of the 13 themes (technological implementations) that emerged from the analysis of the expert semi-structured interviews is provided in Figure 2.

Technology Implementations for developing a hybrid physics module for grades (9-12) students in the Sultanate of Oman:

- Google for Education products
- Mobile Applications
- Instant Messaging
- Digital Projectors
- Microblogs
- Interactive Whiteboards
- Tablet
- Blogs
- Artificial Intelligence
- Virtual Learning
- Augmented Reality AR
- Virtual Reality VR
- Simulation Software Program

Figure 2
An overview of the Themes (Technology Implementations) was produced by analyzing the semi-structured interviews with experts.

The themes that emerged from the expert interviews were used to construct the FD instrument. This instrument consists of the survey or questionnaire that was used to collect expert opinions as well as the methodology for combining and synthesizing these opinions while considering the respondents' inherent uncertainty. The FD instrument for this study incorporates a 5-point Likert scale, with values ranging from 1 (unimportant) to 5 (very important), to determine the degree of relevance. This scale represents a 5-point linguistic scale for measuring agreement, as found in Table 1.

Table 1
Fuzzy scale used in the study

Likert scale	Linguistic variable	Fuzzy Scale
1	Unimportant	(0.0,0.1,0.2)
2	Of little Importance	(0.0,0.2,0.4)
3	Moderately Important	(0.2,0.4,0.6)
4	Important	(0.4,0.6,0.8)
5	Very Important	(0.6,0.8,1.0)

Two sets of validation forms (content and language validation forms) were developed for instrument validation. Two experts examined the language and content of the instrument. Additionally, ten experts who were not part of the study's sample were involved in a pilot test. Using the data from the pilot test, Cronbach's Alpha coefficient was calculated to assess the questionnaire's reliability.

Second Phase: Distributing the Fuzzy Delphi (FD) Instrument

FD instrument in the Fuzzy Delphi Method must be distributed to harness the collective knowledge of experts while accommodating the fuzziness and uncertainty that are frequently present in complicated issues. This instrument is essential to the process of gathering and analyzing data, facilitating informed decision-making and problem-solving. The present study adopted a quantitative approach that involved the distribution of an electronic questionnaire to disseminate the Fuzzy Delphi (FD) Instrument. 10 to 15 experts are the ideal number for the Fuzzy Delphi Method, according to Adler and Ziglio (1996). On the other hand, Jamil and Noh (2020) contended that an excessive number of experts could make it more difficult to choose trustworthy data and complicate the researcher's ability to effectively manage the group. As a result, a panel of twelve experts would be suitable and adequate to carry out this investigation by adopting the Delphi Method. The FD instrument was administered to the experts via an online survey conducted with Google Forms. The questionnaires were developed with a Likert-type scale and five response options. Each expert participated as a respondent, expressing their levels of agreement by selecting the appropriate point on the five-point Likert scale.

Third Phase: Data Analysis Using the Fuzzy Delphi Method

The Fuzzy Delphi Method is an extension of the traditional Delphi Method, which is a structured communication technique used to gather opinions and insights from a panel of experts to make informed decisions or forecasts. The Fuzzy Delphi Method introduces the concept of fuzziness or uncertainty into the Delphi process, allowing experts to provide qualitative judgments or opinions with degrees of uncertainty, rather than just providing clear-cut responses In this study, the Fuzzy Delphi Method (FDM) was employed to evaluate the extent of agreement among experts in determining which of the emerging themes held the highest significance in technology implementations when creating a hybrid physics module. The analysis of data using FDM involved the use of triangle fuzzy numbers and defuzzification.

A conventional, real number represents a broader concept than a fuzzy number. Instead of denoting a single value, it characterizes a connected range of values, each associated with a weight ranging from 0 to 1. Fuzzy triangular numbers, represented as m1, m2, and m3 (m1, m2, m3), were utilized to establish fuzzy scales similar to the Likert scale, with the numbers being presented as odd values. Fuzzy triangular numbers are a type of fuzzy set representation that is used in fuzzy logic and fuzzy mathematics. They are employed to express the degree of consensus of an element to a fuzzy set in a triangular or triangular-shaped manner. Enhanced data precision was achieved with higher numbers on the fuzzy scale. The data was organized into a table to compute the mean value (m1, m2, m3) and the fuzzy values designated as n1, n2, and n3. The expert consensus threshold values (d) for each item were determined to be less than or equal to 0.2 (≤ 0.2), with expert agreement percentages exceeding or equal to 75% ($\geq 75\%$). The threshold value (d) was computed using the following formula.

$$d(\bar{m},\bar{n}) = \sqrt{\frac{1}{3}\left[(m1-n1)^2 + (m2-n2)^2 + (m3-n3)^2\right]}$$

Based on the formula, when the threshold value (d) fell below or equal to 0.2, it indicated that the experts had reached a consensus. Conversely, if the d value exceeded 0.2, further data collection was necessary to validate the item. Besides the threshold value, the FDM also enabled the determination of expert agreement in terms of a percentage, stipulating that each item or the entire construct should exhibit a consensus of 75% or higher.

FINDINGS

The results of this study highlight the significance and ranking of technology implementations in the development of a hybrid physics module for students in grades 9-12 in the Sultanate of Oman, as determined by the Fuzzy Delphi Method (FDM). In Table 2, you can find the outcomes for each technology implementation, including the threshold value (d), the expert consensus percentage, and the defuzzification value (Fuzzy Score A). According to FDM, three primary conditions are considered for the acceptance of each technology application using Triangular Fuzzy Numbers. These conditions include a threshold value (d) ≤ 0.2, an expert consensus percentage ≥ 75%, and a Fuzzy score (A) ≥ the α-cut value of 0.5. Table 2 reveals various Fuzzy Scores (A) representing expert consensus on technology implementations. This information aids in identifying the importance and priority of each technological implementation for the development of a hybrid physics module for grade (9-12) students in the Sultanate of Oman.

Table 2
Experts' views on the importance and the ranking of the technology implementations in the physics hybrid module based on the FDM

No.	Platform/Technology	Triangular Fuzzy Number Process		Defuzzification Process			Results		
		Threshold value (d)	Percentage of Expert Consensus, %	M1	M2	M3	Fuzzy Score (A)	Expert Consensus	Ranking
1	Google for Education products	0.111	91.7	0.467	0.667	0.867	0.667	ACCEPTED	2
2	Mobile Applications	0.111	83.3	0.433	0.633	0.833	0.633	ACCEPTED	3
3	Mobile Instant Messaging	0.1	91.7	0.533	0.733	0.933	0.733	ACCEPTED	1
4	Digital Projectors	0.055	100	0.433	0.633	0.833	0.633	ACCEPTED	3
5	Microblogs	0.2	66.7	0.15	0.35	0.55	0.35	Rejected	-
6	Interactive whiteboard	0.077	83.3	0.417	0.617	0.817	0.617	ACCEPTED	6
7	Tablet	0.219	33.3	0.317	0.517	0.717	0.517	Rejected	-
8	Blogs	0.149	50	0.166	0.366	0.566	0.366	Rejected	-
9	Artificial Intelligence	0.033	100	0.4	0.6	0.8	0.6	ACCEPTED	9
10	Virtual Learning	0.084	91.7	0.433	0.633	0.833	0.633	ACCEPTED	3
11	Augmented Reality	0.061	91.7	0.417	0.617	0.817	0.617	ACCEPTED	6
12	Simulation software program	0.061	91.7	0.416	0.616	0.816	0.616	ACCEPTED	8
13	Virtual Reality	0.219	33.3	0.317	0.517	0.717	0.517	Rejected	-

The findings display the technology implementations of Microblogs, Tablets, Blogs, and Virtual Reality have been subject to non-approval. This conclusion stems from the

FDM that the expert consensus percentage fell short of the necessary 75% threshold. Furthermore, all these rejected items' threshold values (d) were less than 0.2, except for Blogs, which exhibited a value of 0.149. Mobile instant messaging claimed the top spot, which had the highest Fuzzy Score (A) of 0.733. In addition, the threshold value (d) for this item was 0.1, and a significant expert consensus level of 91.7% was observed, highlighting the critical role of instant messaging platforms like Telegram and WhatsApp in enabling the delivery of the physics hybrid module. Conversely, artificial intelligence (AI) occupied the bottom position. With a consensus rate of 100% among experts, there is no doubt about the relevance of AI; however, because of its comparatively low Fuzzy Score (A) of 0.6, it was ranked ninth. With a Fuzzy Score (A) of 0.667, a threshold value (d) of 0.111, and an expert consensus rate of 91.7%, Google for Education goods demonstrated strong performance in the ranking and secured the second position. All experts concurred that the Digital Projector is important, yet it was ranked in third place together with virtual learning and Mobile applications because they all received an identical Fuzzy Score (A) of 0.633. Similarly, the Interactive whiteboard and Augmented Reality, both tied for sixth position with a Fuzzy Score (A) of 0.617, respectively, with a threshold value (d) of 0.077 and 0.061, respectively. Table 3 summarizes the rating of each technological implementation utilized in the development of a hybrid physics module for students in grades 9–12 in the Sultanate of Oman, based on the Fuzzy Delphi Method (FDM).

Table 3
An overview of the FDM Findings

Technology Implementations for the Physics Hybrid Module	Rank
Mobile Instant Messaging	1
Google for Education products	2
Mobile Applications.	3
Digital Projectors.	3
Virtual Learning.	3
Interactive whiteboard	6
Augmented Reality	6
Simulation software program	8
Artificial Intelligence	9

DISCUSSION

To build the physics hybrid module for students in grades 9–12 in public schools in the Sultanate of Oman, nine key technological implementations have been identified to be essential. A variety of factors can influence the ranking's placement. Except for microblogs, tablets, blogs, and virtual reality, this research affirms a unanimous consensus among experts about the essentiality of various technology implementations in the creation of a physics hybrid module. The following items have been ranked in decreasing order of significance: Mobile Instant Messaging, Google for Education products, Mobile Implementations, Digital Projectors, Virtual Learning, Interactive whiteboard, Augmented Reality, Simulation Software Programs, and Artificial Intelligence. In a physics hybrid learning module, mobile instant messaging claimed the highest position because it was easily accessible, allowed for real-time communication, and fostered peer learning and collaboration. It's comfortable, low-barrier, and promotes active student participation. Artificial Intelligence, on the other hand, can be ranked lower due to the challenges of customization, limited integration, technological barriers, and concerns about data privacy and ethics. While mobile instant messaging offers immediate communication, AI may require more development and customization to be effective in teaching difficult subjects like physics. The educational setting and goals will determine which of these tools is best. For example, research by Klieger and Goldsmith (2019) illustrated that the popular mobile instant messaging service WhatsApp plays a vital role in improving students' comprehension of physics concepts. Using WhatsApp, students were able to bolster their understanding of physics by posing questions, seeking assistance from their peers, and exchanging solutions. Additionally, according to Bruneau et al. (2023), ChatGPT is an artificial intelligence (AI) tool, that holds significant promise in enhancing physics education. It accomplishes this through providing individualized support, assisting in problem-solving, and a deeper comprehension of the subject. According to studies done by Mulyadi (2020), the utilization of WhatsApp for communication is considered an advantageous pedagogical strategy in the realm of physics education. Although Artificial intelligence AI occupies the bottom rank, it is still acknowledged as a useful tool for physics education. For example, improving customization of AI tools to meet physics educational needs, and more incorporation of AI into physics teaching methodologies. Furthermore, continued research and development could improve AI's ability to teach physics and other science subjects. Additionally, as claimed by Cheah (2021), the gamification platform incorporated with AI serves as a valuable feedback system for educators, allowing them to adjust and customize the curriculum to address the specific needs of each physics student. Future advancements in AI tools' ranking may rise through several means.

Mulyadi (2020) revealed that utilizing Google Forms for assessments in online physics classes is a valuable approach that benefits both learners and teachers. According to Henukh et al. (2020), Google for Education products, which are a second essential technological implementation for developing a hybrid physics module, have a positive impact on students' academic achievement and physics education.

Three technology implementations share the third position Mobile applications, Digital Projectors, and Virtual Learning. Tangkui and Keong (2023) have demonstrated that using Minecraft in conjunction with fractions education fractions holds promise for facilitating and amplifying students' proficiency in higher-order thinking skills. According to results from the research conducted by Darmaji et al. (2019), physics students have demonstrated a favorable preference for mobile-based learning, especially when interacting with materials related to thermodynamics and basic physics laboratory instructions. Students' academic performance following the utilization of an Android-based digital book has shown a significant surge compared to prior learning outcomes (Hediansah & Surjono, 2019). Moreover, media specialists have exhibited a positive disposition towards mobile learning and assessment tools intended to improve science process abilities and the practical aspects of physics education.

An issue that many schools face when teaching physics is that their science labs are not equipped with enough materials and equipment. This shortage stems from financial limitations and the substantial maintenance expenses associated with lab facilities. Fortunately, recent technological progress offers promising solutions for schools to overcome these budget and cost challenges by using 3D virtual learning environments, which enable a wide range of experiments as revealed by Bogusevschi et al. (2020).

Augmented Reality and Interactive Whiteboard tied for sixth position. The integration of augmented reality (AR) technology into physics education, as indicated by Cai et al. (2021), results in increased student self-confidence, motivates the application of higher-level learning strategies and creates a desire for more in-depth and meaningful interaction with the material. Malkaw et al.'s (2020) study explored the Sultanate of Oman's physics instructors' perspectives on interactive whiteboard adoption. The findings demonstrated that teachers had very positive and significant reactions to this technology.

The simulation software package ranked the seventh position. According to Bogusevschi et al. (2020), students offered positive feedback to a computer-based physics education application that immerses them in the study of natural processes, such as precipitation formation and the water cycle through experimental simulations. The application was also considered an enjoyable educational resource. Furthermore, Prasetya et al. (2022) found that the utilization of PhET Simulations in online physics sessions led to an improvement in students' motivation to learn.

When hybrid learning is implemented effectively, it should be seriously considered by administrators and educational policymakers, especially in underserved communities (Seage & Türegün, 2020). Certainly, technology implementations are essential in the field of education. It is important to carefully organize their integration within a disciplined teaching framework. Educators need to employ their expertise in instructional strategies to ensure that technology not only supplements but also enhances the learning experience. The combination of excellent teaching approaches and technology implementations has the potential to yield more positive educational outcomes. Providing substantial support for hybrid learning within the ongoing educational process, including providing teachers with specialized and continuous training in its implementation, ensures that effective learning can take place even in challenging circumstances (Syafril et al., 2021).

This research provides valuable knowledge for curriculum planners, physics educators, and Ministry of Education stakeholders. It draws attention to the essential technology resources required to provide a unique hybrid physics curriculum for students in grades 9-12. Subsequent research initiatives are encouraged to investigate the application of these modules in various educational settings, spanning a range of educational contexts, from postsecondary education to vocational training.

CONCLUSION

This study offers valuable insights to curriculum designers, physics educators, and stakeholders within the Ministry of Education regarding the noteworthy technological resources fundamental for developing a physics hybrid module that is appropriate for students in grades 9 through 12. There are several advantages to utilizing technology in physics education for high school students. Analyzing the data using the Fuzzy Delphi Method affirmed that experts collectively agreed that employing the essential technology implementations is crucial to developing a pedagogical physics hybrid module. Artificial Intelligence AI resides at the bottom of the ranking, with mobile instant messaging claiming the highest position. Therefore, especially in the Fourth Industrial Revolution period, integrating technological implementations into physics modules is essential for expanding education and digital skills. It is recommended that future research projects investigate the applications of physics hybrid modules in diverse educational institutions, including vocational training, higher education, and at each school level in the high school physics grades (9-12) demographic.

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