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PROCEEDINGS OF JOHOR INTERNATIONAL INNOVATION INVENTION COMPETITION AND SYMPOSIUM 2024 (JIICaS 2024)



*“Flourish and Nurturing Sustainable
Innovation for a Prosperous Nation”*

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Preface

In the name of Allah, the Almighty who gives us the enlightenment, the truth, the knowledge and with regards to Prophet Muhammad (peace be upon him) for guiding us to the straight path. We thank to Allah for giving us guidance and strength to write this e-book.

This e-book compiles the extended abstracts that submitted to Johor International Innovation Invention Competition and Symposium 2024 (JIIICaS2024), where JIIICaS2024 is a virtual platform for all creative minds to share and present their invention and innovation. Each abstract gives a brief background on the innovation or project.

We hope that this e-book will help the readers to get to know the innovation done by the students and get some ideas to develop future innovation products.

Foreword Rector



Assalamualaikum warahmatullahi Wabarakatuh,
Salam Sejahtera, Salam Malaysia MADANI and
Salam UiTM Dihatiku.

In the name of Allah, the Most Gracious, the Most
Merciful.

It is a great honor to welcome you to the Johor
International Innovation, Invention, Competition, and
Symposium 2024 (JIICaS 2024). This event

connects various disciplines, focusing on education and engaging educators,
students, researchers, and innovators from all walks of life.

Innovation is not just about ideas; it demands perseverance, creativity, and
determination to turn those ideas into reality. The remarkable projects
showcased today highlight the dedication and spirit of all participants.
Initiatives like this not only explore new technologies but also cultivate skills
and leadership among our youth. At Universiti Teknologi MARA (UiTM) Johor
Branch, we are fully committed to fostering a dynamic culture of innovation,
promoting the commercialization of new products, and encouraging
meaningful collaborations with industry and society.

As we celebrate this event, I would like to extend my heartfelt gratitude to all
sponsors, judges, the College of Computing, Informatics and Mathematics,
UiTM Pasir Gudang Campus as the event organizer, as well as to the
researchers and participants for their hard work in making this event a
success. Let us continue striving for innovation and excellence. May the
ideas presented today inspire us and lay the groundwork for future
achievements.

Thank you.

Associate Professor Dr. Saunah Zainon
Rector
Universiti Teknologi MARA (UiTM)
Johor Branch

(A-ST056) ENHANCING STEM EDUCATION THROUGH GAME-BASED LEARNING: A CASE STUDY OF 'ENCHANTED ALCHEMICAL ADVENTURES OF ACID AND BASE

Norhayati Binti Mohd Yusof¹, Muhammad Amirul Fahmi Bin Abd Rahim¹, Isma Iwana Binti Ismail¹, Nur Rahwani Rifqah Binti Roseni¹, Umi Humairah Binti Abd Rahman¹, Nur Hazirah Binti Ragzali¹

¹Faculty of Education, Universiti Teknologi MARA Cawangan Selangor, Kampus Puncak Alam,

Corresponding author: norhayatimy@uitm.edu.my (Norhayati Binti Mohd Yusof)

ABSTRACT

Educational resources are crucial for enhancing the effectiveness of lesson delivery. The Game-Based Educational Courseware embraces the 2024 Malaysian Teachers Day theme, "Guru Jauhari Digital Aspirasi Negara Madani," and introduces a revolutionary approach to education by transforming traditional courses into interactive and captivating experiences. This courseware incorporates digitally created educational resources, combining technology and education to create a flexible learning environment that caters to the varying needs of students. Traditional educational methods frequently encounter difficulties in properly captivating students, resulting in restricted academic achievements and disinterested learners. This courseware, created using the ADDIE Model, has two main goals: to encourage the study of STEM courses by employing interactive learning techniques, and to improve critical thinking abilities by including game-based learning that aligns with chemistry curriculum standards. The educational courseware, "Enchanted Alchemical Adventures of Acid and Base," utilises interactive exercises and multimedia components to engage students and enhance their learning experience. The programme incorporates the use of repetition and reinforcement in an interactive game format to guarantee the long-term retention of information. Initial results suggest that the courseware has notable advantages, such as being in line with curriculum standards, improving ICT skills, and promoting critical thinking and problem-solving abilities. Furthermore, it provides self-paced educational resources, enhancing the learning process. By utilising this groundbreaking method, instructors are able to establish enhanced learning environments that stimulate and encourage pupils. The Game-Based Educational Courseware not only aligns with curricular standards but also promotes dynamic and pleasant educational experiences, hence ensuring improved learning results.

Keywords: Game-Based Educational Courseware, STEM Education, Critical Thinking Skills, Game-Based Learning, Self Learning

INTRODUCTION

In secondary education, conventional teaching methods have primarily relied on traditional approaches centered around physical textbooks containing textual information and static images. While these resources serve as essential tools for knowledge transmission, they may not effectively engage all students. Many learners become disinterested and disengaged when passively consuming information from

textbooks, leading to a sense of monotony and disconnection from the learning process (Papastergiou, M., 2009). This disengagement particularly disadvantages STEM subjects, making it harder for students to understand and memorize concepts. This lack of engagement is especially pronounced in STEM subjects, where abstract concepts and complex theories can be difficult to grasp without interactive and dynamic instructional methods. The result is often a superficial understanding of the material, where students can memorize facts for tests but fail to develop a deep, conceptual understanding necessary for advanced study in science and technology fields. The courseware transforms traditional chemistry lessons into an immersive game-based adventure (Gee, 2003). Students navigate through a magical world as budding alchemists, completing quests and solving puzzles that are directly related to the curriculum content. To cater to diverse learning styles (Mayer, 2009), the courseware integrates various multimedia elements, including text, pictures, videos, voice-overs, and background music. This multimedia approach not only makes learning more engaging but also helps students better understand and retain complex concepts. By making chemistry fun and interactive, the courseware aims to reverse the declining trend of students enrolling in science streams (Chen, H. Y., Liao, C. H., Chang, C. H., & Wu, H. K., 2018). The engaging content helps demystify scientific concepts, making them accessible and enjoyable for all students.

In alignment with the theme of this year's Teachers' Day, "Guru Jauhari Digital, Aspirasi Negara MADANI," the courseware enhances ICT (Information and Communication Technology) skills among teachers. It provides educators with modern tools and techniques to deliver lessons more effectively (Mishra & Koehler, 2006). The courseware encourages creative thinking and problem-solving skills among future educators, supporting the Ministry of Education's targets for fostering innovation in teaching methods. Recognizing the diverse needs of learners, the courseware is designed to be inclusive and adaptive (Rose & Meyer, 2002). It offers features that cater to special needs students, providing an alternative to traditional textbook-based learning environments. The courseware is designed to be integrated into the curriculum of secondary schools to make chemistry more engaging and accessible. It is also suitable for tertiary institutions offering bachelor's degrees in Education, providing future educators with innovative teaching tools. The adaptive design ensures that students with special educational needs can also benefit from this interactive learning approach. By incorporating game mechanics into learning, students are more likely to stay engaged and motivated (Prensky, 2001). Interactive simulations and real-time feedback help students grasp complex chemistry concepts more effectively.

The Game-Based Educational Courseware revolutionises conventional chemistry courses by converting them into an engaging and interactive experience. Students assume the roles of aspiring alchemists, exploring a fantastical realm complete with challenges and enigmas that exactly correspond to the curriculum material. This creative method utilises a range of multimedia components, such as text, images, videos, voice-overs, and background music, to accommodate different learning preferences.

METHOD

The courseware is intentionally designed to be inclusive and flexible in order to accommodate the varying needs of learners. It provides customised features for students with unique needs, offering a valuable alternative to standard learning settings that rely on textbooks. The courseware is specifically designed to be integrated into the secondary school curriculum, with the aim of making chemistry more captivating and easily understandable. Utilising interactive simulations and providing real-time feedback enhances students' comprehension of intricate chemistry subjects with greater efficacy. Utilising multimedia components improves the ability to remember and retrieve information. The courseware also facilitates the cultivation of critical thinking, problem-solving, and ICT abilities in both students and teachers. This courseware has been created utilising advanced PowerPoint abilities and techniques. It is designed to be easily available on any browser and device, providing users with flexibility and a user-friendly experience.

The development of the Game-Based Enchanted Alchemical Acid and Base Courseware followed the **ADDIE model**, which comprises five phases: Analysis, Design, Development, Implementation, and Evaluation. Each phase was meticulously executed to ensure the creation of a high-quality, engaging educational tool. In the **Analysis phase**, a comprehensive needs assessment to identify the gaps in current chemistry education, particularly in the areas of acids and bases, revealed a lack of engagement with traditional teaching methods. We also reviewed curriculum standards to align the courseware's content with educational requirements. The target audience was defined as secondary school students.

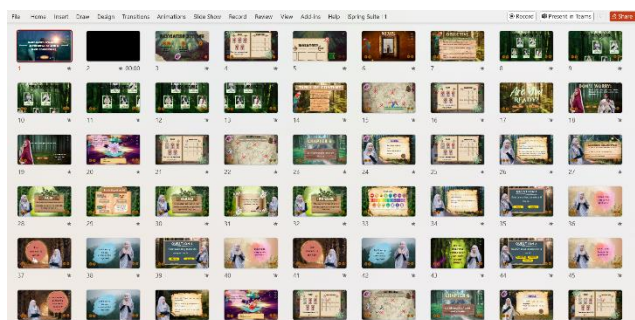


Figure1: Example of the layout design of the game-based courseware



Figure 2: Using ADDIE MODEL to develop the Game-Based Educational Courseware is shown in the Digital Poster

During the **Design phase**, the courseware’s learning objectives and outcomes been developed. We created detailed storyboards and scripts to integrate educational content seamlessly with game elements. The design included interactive simulations, content and quizzes to enhance engagement. Visual and audio elements, such as animations, voice-overs, and background music, were carefully selected to complement the storyline and reinforce learning objectives. We also planned for adaptive learning paths to cater to varying student abilities. In the **Development phase**, the actual creation of the courseware took place. team members collaborated to bring the design to life. The interactive modules, animations, and game mechanics were developed using basic educational technology tools with advanced skills. Continuous testing was conducted to ensure functionality and usability. The **Implementation phase** involved deploying the courseware in selected pilot schools. Briefing sessions were conducted for educators to familiarize them with the courseware and its features. The team members provided technical support and resources to ensure smooth integration into the existing curriculum. Students began using the courseware, and their engagement and performance were closely monitored. In the **Evaluation phase**, both formative and summative assessments were conducted to measure the courseware’s effectiveness. Data were collected on student engagement, understanding of chemistry concepts, and overall satisfaction. Feedback from educators and students was analyzed to identify areas for improvement. The results showed a significant increase in student interest and comprehension in STEM subjects. Based on the findings, final adjustments were made to enhance the courseware further. By following the ADDIE model, the development of the Game-Based Enchanted Alchemical Acid and Base Courseware was systematic and effective, resulting in a robust educational tool that promotes STEM education and fosters a deeper understanding of chemistry through engaging, interactive learning.

FINDINGS

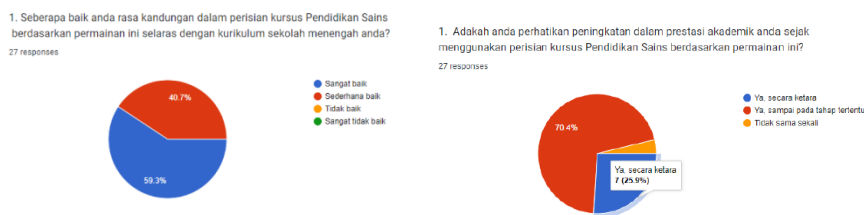


Figure 3: Positive feedback related to the contents

The game-based educational courseware underwent a pilot test with 27 form four students, yielding overwhelmingly positive feedback. Students reported heightened levels of understanding, follow the syllabus, find new content and updates, the content is appropriate with the culture and social contexts of the Malaysian students, increased engagement compared to traditional methods, and a sense of enjoyment during the learning process. The efficacy of game-based educational courseware in assisting STEM students is extensively documented (Annetta, Minogue, Holmes, & Cheng, 2009). By offering a captivating and participatory educational setting, it facilitates the cultivation of a more profound comprehension of scientific principles among students. This method not only improves academic achievement but also fosters a better enthusiasm for STEM subjects. The courseware's capacity to enhance the enjoyment and accessibility of learning has the potential to substantially augment student enrollment in science streams, thereby satisfying a crucial requirement in contemporary education.



Figure 5: High level of motivation using the game-based educational courseware.

The Game-Based Educational Courseware is a notable progression in the field of chemical teaching. By converting conventional teachings into immersive experiences, it captivates students, accommodates various learning requirements, and provides educators with cutting-edge resources. This technique offers the potential to improve the whole learning experience, by making chemistry more attractive and easily understandable for all students. Ultimately, it will help to establish a firmer basis in STEM education. The courseware's inclusive design and adaptability guarantee that all students, irrespective of their learning style or needs, can derive substantial and captivating educational benefits.

CONCLUSION

The "Game-Based Enchanted Alchemical of Acid and Base Courseware" addresses a critical challenge in Malaysian education: low student enrollment in STEM fields. By integrating gamification with educational content, this innovative courseware transforms traditional chemistry lessons into engaging and interactive experiences, making learning both enjoyable and effective. This initiative aligns with Malaysia's educational goals of enhancing digital literacy and preparing students for a technologically advanced future. The Game-Based Enchanted Alchemical of Acid and Base Courseware has reached Technology Readiness Level (TRL) 7. The justification for this grade lies in the fact that the product has undergone thorough pilot testing, during which input was collected and used to make essential modifications and enhancements. After making these changes, the courseware has been put into use in three distinct educational institutions, including an international school. This showcases its efficacy and dependability in various educational settings. In addition, the courseware has obtained official copyright, guaranteed its protection as intellectual property and confirming its authenticity and originality. The courseware's successful implementation and functioning in these real-world environments demonstrate its functionality and its ability to meet the educational requirements and standards necessary for wider use. Therefore, TRL 7 precisely indicates the advanced level of development of the courseware, emphasising its preparedness for extensive use and additional verification in practical educational settings.

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