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e ISBN 978-967-2776-41-3

International Conference in Business Management & Innovation (ICBiv) 2023

"Leveraging Innovativeness Towards Sustainability"

18 - 19 SEPTEMBER 2023

Proceeding Book

ICBiv 2023

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Department of Business and Management, UiTM Perak Branch

INTERNATIONAL CONFERENCE ON BUSINESS MANAGEMENT & INNOVATION

(ICBiv) 2023

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Perpustakaan Negara Malaysia Cataloguing in Publication Data
No e ISBN: 978-967-2776-41-3

Cover Design: Ts Dr Umol Syamsyul Rakiman
Typesetting : Ts Dr Umol Syamsyul Rakiman
Dr Wan Maisara Wan Mohamad

INTERNATIONAL CONFERENCE ON BUSINESS MANAGEMENT AND INNOVATION 2023
https://icbiv2023.wixsite.com/icbiv2023

DIGITAL GAME BASED LEARNING TOOLS: AN ANALYTIC HIERARCHY PROCESS (AHP) IN ECONOMICS-RELATED COURSES AT TERTIARY EDUCATION LEVEL

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ABSTRACT

Most tertiary students find it difficult to learn economics, especially during pandemic and endemic times of Covid 19. Low levels of visualisation abilities and memory problems are the main obstacles to learning economics, which prevent students from understanding the subject's theory and applications. The purpose of this concept paper is to identify the priorities and selection criteria that tertiary education students utilise while selecting digital gaming-based learning resources for economics-related courses. In this study, 100 students enrolled in tertiary education at the UiTM Perak Branch Tapah Campus will complete a pair-wise comparison survey. The Analytical Hierarchy Process (AHP), a multi-criteria decision-making process, will then be used to assess their judgements. Two main criteria were considered, "Environment Factors" and "Persuasion Factors," with a total of nine sub-criteria. The conceptual study on DGBL tools employing the analytical hierarchy process (AHP) in higher education level economics courses is crucial because tertiary educational institutions can implement the choice strategies and entice students to utilise DGBL tools when studying for courses connected to economics. In order to further enhance the utilisation rates of DGBL tools in the classroom, tertiary educational institutions, particularly the lecturer or instructors, should leverage on the criteria that tertiary education students are expected to value.

Keywords: *DGBL, Economics, tertiary education students, decision making, priorities Analytic Hierarchy Process, AHP.*

1. INTRODUCTION

Most tertiary students find learning economics difficult, particularly during pandemic and endemic times of Covid 19. According to Johari, Ali, Hassan, Mokhtar, Wahid, Noordin & Ibrahim (2018), the main challenges in learning economics are poor memory retention and a lack of visualisation abilities, which prevent students from understanding the economics concept and its application. As a result, Noviani (2021) proposed using the internet to find instructional materials and media to help students who are having trouble learning economics. According to Gyöngyösi Wiersum (2013), game-based learning and teaching are important to the teaching profession. Lopez-Fernandez (2021) added that educational games can help pupils study in a fun environment while also enhancing their capacity for learning. This proves that a fun learning environment for economics has the ability to boost students' academic performance.

Information and communication technology (ICT) advancements have led to the development of the playful approach of digital game-based learning, which turns the learner into an active participant rather than just a spectator in the virtual and physical learning environment. It is a digital simulation tool that can improve motivation and student involvement while also enhancing the efficiency of instruction. The incorporation of this instructional technology into the teaching and learning process can help students build new information, acquire new skills, and develop new attitudes. A subclass of serious games called digital game-based learning (DGBL) mixes computer games and instructional content (Prensky, 2001a). In addition, DGBL makes use of cutting-edge tools that are widely considered to have a considerable potential to stimulate active learning, problem-solving, and communication while providing a setting that promotes practise and learning through failure. Digital game-based learning may improve students' learning performance (Lin, Yen & Wang, 2018), motivation to learn (Su, 2016), cognitive load (Chen and Huang, 2020), and anxiety (Su, 2016).

It's critical to update economics-related courses with game-based learning due to the world's quick change. Digital game-based learning has just recently been investigated in a few distinct topics, including STEAM (Chen and Huang, 2020), English (Yang and Chen, 2020), maths (Hung, Huang, & Hwang, 2014), and the sciences (Chen, 2019). The impact, effectiveness, and efficiency of digital game-based learning have also been extensively studied, but little study has been done on the factors and priorities that students in higher education use to choose DGBL tools. In addition, research on digital game-based learning has only a few Analytic Hierarchy Process (AHP) evaluations. The goal of the concept paper is to identify the priorities and selection criteria that tertiary education students utilise while selecting digital gaming-based learning resources for economics-related courses. The following are the research questions:

i. What are the criteria and priorities used by higher education students in choosing digital game-based learning tools in economics-related courses?

ii. What is the priority for each criterion used in selecting digital game-based learning tools in economics-related courses?

2. LITERATURE REVIEW

The importance of student participation in achieving a shared objective is emphasised by the Computer-Supported Collaborative Learning (CSCL) theory. Skillful curriculum and technology preparation, coordination, and implementation are necessary to achieve the goal (Koschmann 1996; Barbara 1998; Stahl, Koschmann, & Suthers 2006). CSCL emphasises that knowledge is the outcome of learners interacting with one another, exchanging knowledge, and both individually and collectively generating knowledge (Resta & Laferrière, 2007). It integrates the ideas of social-constructivist, contextual learning, and cognitivist learning theories. In addition, this study used three crucial variables—environment, motivation, and persuasion—to choose the digital game-based learning (DGBL) tools that are further addressed.

2.1 Environment

Constructivist Learning Environments (CLES) are a broad range of strategies that support conceptual development and problem-solving, according to Jonassen (1999). Researchers and educators can follow the development of constructivist learning environments with the use of CLES, which Taylor et al. first established (Taylor & Fraser, 1991). The reactions to four factors—negotiation, prior knowledge, autonomy, and focus—can be used to gauge how people feel about a learning environment.

The efficacy of DGBL for teaching and learning as well as learners' perceptions of information and technology (IT) were examined through empirical research by Johnson (2019). He affirmed that the participants' opinions of a constructivist classroom at the junior high school level seem to be favourable. A new learning environment will also be readily accepted if participants experience ownership through negotiation, if it turns out to be more engaging than current methods, and if learning occurs their results in concrete outcomes (Johnson, 2019).

Additionally, Lagrimas & Buenaventura (2023) found that the constructivist learning environment and degree of school culture as assessed by technology and livelihood education students in Davao del Sur, Philippines, are both enhanced. This study's findings suggest that constructivist learning environments are highly valued by learners. A constructivist learning environment is one in which psychological and pedagogical factors influence students' attitudes, success, and learning.

However, Yeo, Cho & Hwang (2022) noted that improvements in female learners' learning performance outpaced those in male learners, particularly in the low previous knowledge category. Students with little background knowledge were more likely to be distracted by their surroundings and peers. The purpose of this study is to find out how gender and prior knowledge affected the academic performance and motivation of Taiwanese fifth graders.

Nguyen, Jin, Hoang, Nguyen, Nguyen, Le, & Vuong (2023) found that high school students' growth of digital creativity is positively impacted by their digital capabilities and openness. Parental and teacher support moderates the association between autonomous student learning and digital innovation. According to Nguyen et al. (2023), kids' capacity to use digital devices, openness to new knowledge sources on the Internet platform, and independent learning with parental and academic support can all be improved. This study looks into the elements that help Vietnamese high school students enhance their digital creativity. Newton's laws of motion were the subject of Wu, Tzeng and Huang's (2020) investigation and comparison of the effectiveness of digital game-based learning (DGBL) and static e-learning materials on students' learning attention, affective experiences, cognitive load, and academic performance. This study showed that the main advantages of DGBL learning are improved emotional health and increased focus when compared to traditional e-learning methods.

2.2 Persuasion

One of the five key components in the transmission of new ideas, persuasion serves to help people recognise the advantages of innovation (Rogers, 2010). Rogers (1995) asserts that persuasion happens when someone has a favourable or unfavourable attitude towards innovation. The following elements must be taken into account for an innovation to spread and be adopted quickly: relative advantage, compatibility, complexity, trialability, and observability (Rogers, 2010).

According to Johnson (2019), participants' impressions of DGBL seem to be somewhat in favour of it (persuasion). Potential users will be more likely to adopt a new technology if they believe it is superior to earlier inventions, compatible with current practises, easy to comprehend and apply, and yields measurable outcomes (Johnson, 2019; Rogers, 2010; and Rogers Everett, 1995). Additionally, Janowicz (2019) found that when persuasive message arguments were strong in higher education, peer-assisted learning and peer efficacy were helpful in promoting and using DGBL.

Franciosi (2014) and Franciosi (2016) claim that foreign language (FL) instructors in Japanese higher education with a research interest in computer-assisted language learning (CALL) are more likely than instructors with other research interests to have favourable views on the relative benefit and compatibility of role-playing game (RPG)/simulators.

According to Franciosi (2014), increasing trialability raises the possibility of adoption. In order to address a wide range of learning/teaching objectives, a diverse set of resources should be created, with samples made freely available online for educators to experiment with.

2.3 Motivation

Plass, Homer & Kinzer (2015) assert that DGBL is primarily seen from a motivational perspective, with a focus on games' capacity for engagement and motivation. He acknowledged that the main goal of motivational theories is to provide answers to questions that draw attention to the variety of elements that affect motivation. Intrinsic Motivation Inventory (IMI) components such as competence, happiness, enjoyment, interest, and autonomy are categorised by Johnson, 2019, Deci & Ryan, 2003, and Ryan & Deci, 2000.

When DGBL content is used in the classroom, Johnson (2019) and Woo (2014) found that students are more inclined to interact with it. According to research by Yousef, Baadel and Makad (2014), game-based learning has a positive effect on students' intrinsic and extrinsic motivation levels and performance in both academic and soft- skills areas. Furthermore, game mechanics analyses show how online game-based technologies help learners learn by energising them with enjoyable learning settings and quick feedback. In higher education foreign language courses, he looked at online gamified resources for formative evaluation (Zhyhadlo, 2022). The use of DGBL in higher education has been discovered to have theoretical and practical ramifications, and Janowicz (2019) stressed the need of understanding and motivating adult learners as well as incorporating them in the co-design of educational innovations.

A game-based educational environment increases learners' attention and motivates them to research and take part in educational activities, according to an empirical study by Orhani (2023). The purpose of the study is to describe how basic mathematical ideas can be taught and learned more effectively via digital games. Additionally, Jonker, Vincent, and Wijers (2008) looked at how computer games affect motivation, interest, and problem-solving abilities. It is supported by numerous research findings.

Other research by Orhani (2023) shows that digital computer games can significantly improve students' understanding of and enjoyment of mathematics. Students engage in active learning when they "think and evaluate the mathematics embedded in digital games with three factors that are particularly vital in concentrating students' attention on mathematics: student attitudes, support activities, and collaborative play" (Orhani, 2023).

Additionally, according to Fang, Tapalova, Zhiyenbayeva & Kozlovskaya (2022), a child with a higher Social Competence score exhibits prosocial behaviour and is happier, more tolerant, socially integrated, calm, and willing to cooperate with peers. The findings of this study may help parents and educators make efficient use of digital learning tools, particularly video games, when dealing with young children. The Multiplication Game (MG) should have a permanent place in the teaching process for the purpose of students' progress monitoring and self-evaluation as well as a fun way to exercise and develop multiplication skills, according to Leonardou, Rigou, Panagiotarou, & Garofalakis (2022), who also supported the claims made by participating educators.

A previous study examined a potential approach to teaching with Minecraft by having Norwegian high school students take notes while playing the game, followed by a test to assess their memory. Enjoying the assigned activity and playing the game together with other relevant interactions were found to have important effects. It's also important to note the correlation between enjoyment of the activity and motivation to perform well, both of which predicted exam scores. Interestingly, the results suggest that task satisfaction is a potential mediating factor for these traits (Reynisson, 2023).

Papanastasiou (2022) claims that serious games satisfy a number of fundamental psychological needs, including those for autonomy, competence, and relatedness, which lead to some form of reward or satisfy a particular basic need related to encouragement.

Previous research has mostly focused on the influence, impacts, efficacy, and efficiency of digital game-based learning, omitting to investigate the criteria and priorities utilised by students in higher education to choose DGBL tools. In order to close the gap, this study investigates the criteria and priorities employed by tertiary education students while selecting digital game-based learning aids.

3. METHODOLOGY

The Analytical Hierarchy Process (AHP) was employed in this study as an MCDM, or multi-criteria decision-making process. One of the multi-criteria decision-making techniques Saaty (2012) describes to produce ratio scales from paired comparisons is AHP. There are three processes in AHP that the researcher must take to make decisions regarding the importance of the criteria (Brunelli, 2015). The first phase involves asking the respondents to compare the criteria in pairs. The definition of the scale, which ranges from 1 to 9, is given in Table 1.

Intensity of Importance	Definition
1	Equal importance
2	Weak
3	Moderate importance
4	Moderate plus
5	Strong importance
6	Strong plus
7	Very strong or demonstrated importance
8	Very, very strong
9	Extreme importance

Table 1: Saaty's Pairwise Comparison Scale (Saaty, 2012)

If there are m criteria to be evaluated, then the respondent has to make $\frac{m(m-2)}{2}$ comparisons. For example, 10 pairs of criteria will be compared if the number of criteria is 5. Suppose criterion 1 is compared with criterion 2. If criterion 1 is 'strong importance' compared to criterion 2, then m_{12} = 5, and m_{21} = $\frac{1}{5}$. All the pair-wise comparisons collected from each respondent were transferred into matrix form, M, where $m_{jk} = \frac{1}{m_{kj}}, k > j$ such as in Figure 1.

$$M = \begin{bmatrix} 1 & m_{12} \cdots & m_{1n} \\ m_{21} & 1 \;\; \cdots & m_{2n} \\ \vdots & \vdots \;\;\; \vdots & \vdots \\ m_{n1} & m_{n2} \ldots & 1 \end{bmatrix}$$

Figure 1: Matrix M

Evidently, one of the major drawbacks of AHP is that the number of pair-wise comparisons increases exponentially as the number of criteria increases. In Step 2, the degree of consistency is then measured by the Consistency Index (CI). Perfect consistency implies a value of zero, but as individuals' judgments are often inconsistent, it is difficult to comply. Therefore, inconsistency up to a certain degree is acceptable in computing pair-wise judgements. The CI for M is calculated as

$$CI = \frac{\lambda_{max} - n}{n-1}$$

(1) where λ_{max} is the maximum Eigen vector of matrix M. If the consistency ratio, $CR = \frac{CI}{RI} <$ 0.10, then the degree of consistency is acceptable, where the random index, RI values are given in Table 2 (Taylor III, 2004).

Number of criteria, (n)	Random index (RI)
2	0.00
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41

Table 2: Random Index, RI, Values (Saaty, 2012)

In the third step, the weight for criterion $j, j = 1, 2, \ldots, n,$ for each respondent's evaluation is calculated by using the following formula:

$$w_j = \frac{1}{n}\sum_{k=1}^{n} \frac{m_{jk}}{\sum_{i=1}^{n} m_{ik}} \quad (2)$$

Every criterion is again considered after repeating this process. Next, if more than one respondent is used in a study, the rule for aggregating judgements in a comparison matrix is to aggregate the judgements using the geometric mean. The weight values can then be used to establish the ranking of the criteria. A criterion's ranking in relation to other criteria increases as its weight increases. Saaty and Peniwati (2007) and Saaty and Alexander (2013). The final weight for criterion j is calculated as a geometric mean if p respondents participated in the assessment, which is done by taking the pth root of the product of all p weights for that criterion.:

$$w_j = \sqrt[p]{w_{j(1)} \times \ldots \times w_{j(p)}}$$

(2) Purposive sampling will be used in this study to select tertiary students who have already used DGBL in class for economics-related courses during their study at the UiTM Perak Branch Tapah Campus. 100 students will be sampled for the study. The Google Form used to produce the surveys will be used to distribute them online. Each respondent will receive instructions on how to complete the pairwise comparison questionnaire for the various study criteria.

There are two main criteria that were identified and considered for the study, which are environment factors and persuasion factors with nine 'covering criteria'. The nine covering criteria are shown in Table 3. The final major criteria, motivation, was discarded for this study due to research limitations, primarily a lack of time and money.

Each respondent will be asked to rank the importance of each criterion in relation to the others after the criteria have been established, and the evaluation will then be turned into the matrix shown in Figure 1. Then, using equation (1), the weights of the criterion will be determined. The geometric mean approach described in equation (3) will be used to aggregate all verdicts.

Environment Factor	Persuasion Factor
Autonomy	Compatibility
Learner Focus	Complexability
Negotiation	Observability
Prior Knowledge	Relative Advantage
-	Trialability

Table 3: Educational Pathway Selection Criteria (Johnson, 2019)

4. RESEARCH TIMELINE

The project is expected to be completed in 17 weeks with the following indicated as the activity's durations for every section of the research project:

Research Section	Duration
1. Title	1 week
2. Introduction	2 weeks
3. Need for this Study	2 weeks
4. Background	4 weeks
5. Objectives	1 week
6. Research Questions and or Hypothesis	1 week
7. Research Methodology	4 weeks
8. Data analysis interpretations and discussions	4 weeks
9. Summary conclusion and recommendations	3 weeks
10. Reviewing work for final submission	1 week

Table 4: Timeline for Research

5. CONCLUSION

The conceptual study on DGBL tools employing the analytical hierarchy process (AHP) in higher education level economics courses is crucial because tertiary educational institutions can implement the choice strategies and entice students to utilise DGBL tools when studying for courses connected to economics. In order to further enhance the utilisation rates of DGBL tools in the classroom, tertiary educational institutions, particularly the lecturer or instructors, should leverage on the criteria that tertiary education students are expected to value as majority of studies on digital games have found that using DGBL tools has a good effect on learning, pushing students to learn or evaluate information in a fun and creative way.

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Perkara di atas adalah dirujuk.

2. Adalah dimaklumkan bahawa pihak kami ingin memohon kelulusan tuan untuk mengimbas (*digitize*) dan memuat naik semua jenis penerbitan di bawah UiTM Cawangan Perak melalui Repositori Institusi UiTM, PTAR.

3. Tujuan permohonan ini adalah bagi membolehkan akses yang lebih meluas oleh pengguna perpustakaan terhadap semua maklumat yang terkandung di dalam penerbitan melalui laman Web PTAR UiTM Cawangan Perak.

Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah,

SITI BASRIYAH SHAIK BAHARUDIN
Timbalan Ketua Pustakawan

nar

Setuju.

27.1.2023

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