Development of a Game Based Learning (GBL) Model Assisted by Escape Room to Improve Conceptual Understanding and Self-Efficacy

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Abstract – *The purposes of this study were to (1) describe the design of the GBL model assisted by an Escape Room that was developed to improve students' conceptual understanding and self-efficacy, (2) produce a high-quality GBL model assisted by an Escape Room that is suitable for use in terms of content validity, construct validity, and model coherence, (3) identify students' profiles regarding the GBL model assisted by an Escape Room based on the results of limited implementation and user feedback, (4) determine the implementation quality of the GBL model assisted by an Escape Room in physics learning, and (5) examine the effectiveness of the GBL model assisted by an Escape Room in improving students' conceptual understanding and self-efficacy. The study was conducted at a senior high school in Purbalingga with one experimental class and two comparison classes. The research model employed was the 4D model. The instruments used included tests, questionnaires, and observation sheets. The analysis techniques consisted of Sbi, Aiken's V to measure content validity, empirical validity using Rasch model analysis with INFIT MNSQ values ranging from 0.7 to 1.3, along with normality tests, homogeneity tests, MANOVA, and one-way ANOVA to determine differences in the impact of the product intervention. The findings showed that (1) the characteristics of the developed model, from the learning syntax to the media produced, created meaningful and memorable learning experiences, (2) the GBL model assisted by an Escape Room fell into the appropriate category, (3) there was an improvement in learning outcomes and differences in treatment between classes, with the experimental class achieving the highest results, (4) the model was proven to be practical with full implementation in the classroom, and (5) the GBL model assisted by an Escape Room was effective, as indicated by the effect sizes for conceptual understanding and self-efficacy, which were 0.380 and 0.427 respectively. This model demonstrates strong potential for use in challenge-based or gamified thematic learning in classroom settings.*

Keywords*: Escape Room; GBL; Self-efficacy*

INTRODUCTION

Advances in technology in the era of the Industrial Revolution 4.0 require the education system to equip the younger generation with new competencies and skills. Modern education emphasizes mastery of twenty-first century skills, including critical thinking, communication, creativity, and collaboration. Collaboration skills in learning help strengthen conceptual understanding, since students complement each other's knowledge, correct misconceptions, and connect concepts to real-life situations (González-Pérez & Ramírez-Montoya, 2022).

In addition to conceptual understanding, self-efficacy is also an important internal factor that influences learning success. According to Bandura (1997), self-efficacy refers to an individual's belief in their ability to achieve certain outcomes. Students with high self-efficacy tend to be more persistent and confident when exploring information and understanding new concepts, even when they face difficulties.

However, conditions in the field show that students' conceptual understanding and self-efficacy remain challenging across many educational settings. Observations

conducted at a senior high school in Bobotsari, Purbalingga Regency, Central Java revealed that many students struggle to understand subject matter conceptually, especially abstract topics. They also often hesitate to explain the reasoning behind their answers and tend to be passive. Other studies have also reported that most students demonstrate a moderate level of self-efficacy, which is not sufficient to support independent problem-solving (Muchtar, 2024).

These conditions indicate that the learning approaches currently used have not fully met students' learning needs. This situation calls for learning models that are more innovative, participatory, and contextual, and that encourage knowledge exploration while building confidence. One promising approach in this context is Game Based Learning (GBL). Prensky (2001) explains that GBL can foster learning motivation when it incorporates elements such as challenge, competition, and immersive experiences.

Nevertheless, Gomez et al. (2022) note that GBL is not without limitations. Several studies have found that highly dominant visual elements without appropriate scaffolding may distract learners and reduce instructional effectiveness. In addition, game-based learning models sometimes require substantial financial resources and complex evaluation procedures.

A GBL model assisted by an Escape Room is offered as a solution to these limitations. This model presents learning through mission-based games that include storylines, puzzles, and teamwork. Through these activities, students engage not only cognitively but also emotionally and socially, which has a positive impact on conceptual understanding and the reinforcement of self-efficacy. Such activities encourage reflection and help build confidence as students succeed in completing missions (Zhu et al., 2020).

Although various Escape Rooms have been developed for science learning in fields such as chemistry, biology, and mathematics, research on their application specifically in physics education remains limited. The development of a GBL model assisted by an Escape Room in the context of physics learning therefore represents a promising strategy to address current educational needs.

This study aligns with previous research showing that Escape Room approaches can enhance active participation, collaboration, and learner motivation. For instance, Gordillo and López-Fernández (2024) found significant improvements in knowledge acquisition and student engagement through digital Escape Rooms compared to conventional lectures. Zhu et al. (2020) also reported substantial increases in problem-solving ability and self-efficacy through GBL. Additionally, Maulina et al. (2023) found that digital GBL media improved students' biographical writing skills.

For these reasons, developing a GBL model assisted by an Escape Room in physics education is a promising strategy to meet the demands of today's educational landscape. It has the potential to strengthen students' conceptual understanding and self-efficacy, enabling them to learn more easily and enjoyably.

RESEARCH METHODS

This study employed a Research and Development (R&D) approach using the 4D model, which includes the stages Define, Design, Develop, and Disseminate. The purpose was to produce a Game Based Learning (GBL) model assisted by an Escape Room and supported by a collaborative learning approach that is valid,

practical, and effective in improving conceptual understanding and self-efficacy among tenth grade students on the topic of global warming. The product developed in this study includes a learning model, instructional materials, and an Escape Room scenario.

The research was conducted from April to May 2025. The participants consisted of three classes selected through cluster random sampling: one experimental class (XF) and two comparison classes (XE and XD), each consisting of 34 students. The experimental class received the GBL model supported by the Escape Room media. The first comparison class was taught using a GBL model without the Escape Room media, and the second comparison class used a conventional direct instruction model.

Table 1. Instruction Design

Group	Pretest	Perlakuan	Posttest
Experiment	X	Model GBL + *Escape Room*	Y
Contrast 1	X	Model GBL - *Escape Room*	Y
Contrast 2	X	Konvensional Model	Y

Define Stage: This stage aimed to identify learning needs. Observations in the school indicated that learning activities remained conventional, and students had difficulty understanding concepts and exhibited low self-efficacy. The needs analysis suggested the importance of learning media that are engaging, challenging, and capable of supporting active participation and collaboration. The GBL model assisted by an Escape Room was selected as a response to this need.

Design Stage: This stage focused on developing learning instruments and preparing data collection tools. The materials produced included a draft of the digital Escape Room media, a teaching module, pretest and posttest items, a self-efficacy questionnaire, a student response questionnaire, observation sheets, and validation sheets. The Escape Room media, developed using Google Forms, was titled "The Green Code: Mission to Save the School" and consisted of three challenges designed to stimulate conceptual understanding and self-efficacy.

Develop Stage: This stage included expert validation and limited trials. Expert validation was carried out on the teaching module, learning media, and worksheets. Empirical validity and reliability were examined using Rasch model analysis with JAMOVI.

Disseminate Stage: The final product was distributed to physics teachers at the school and published in the form of a scientific article in an electronic journal.

Data were analyzed using descriptive and inferential statistical techniques. Descriptive analysis was used to describe the feasibility, practicality, and learning outcomes. The SBi method was used to analyze ordinal-scale data. Inferential analysis included prerequisite tests such as normality and homogeneity tests, where data were considered normal and homogeneous if the p-value exceeded 0.005. Hypothesis testing consisted of a One-Way MANOVA to examine simultaneous differences in conceptual understanding and self-efficacy across groups. A One-Way ANOVA was used to test differences in the mean of each variable individually. Post hoc tests using Tukey HSD were conducted if the ANOVA results were significant. Effect size was calculated to determine the practical magnitude of the model, and omega squared (ω^2) was interpreted based on Cohen's (2013) criteria.

RESULTS AND DISCUSSION

This section presents the findings from the development and implementation of the

GBL model assisted by an Escape Room, including observational data and the model's effectiveness in improving conceptual understanding and self-efficacy.

Result

Define Stage: The initial observations showed that learning activities were still conventional and largely teacher-centered, resulting in low student participation. This contributed to students' low conceptual understanding and self-efficacy. Based on the needs analysis, learning media that could enhance participation, collaboration, and confidence were required. The Merdeka Curriculum emphasizes that learning media should support critical thinking, scientific reasoning, and problem-solving. For this reason, a GBL model assisted by an Escape Room was selected to provide a learning experience that is challenging, collaborative, and meaningful.

Design Stage: This stage focused on designing digital learning media, teaching modules, and pretest and posttest items for indicators of conceptual understanding and self-efficacy. The media were designed using interactive Google Forms and included three main missions: (1) Global Warming Grid, (2) Sustainable Match-Up, and (3) Maze of the Renewable Path. All components of the Escape Room were aligned with the scientific learning syntax while being presented through an interactive and contextual game narrative, allowing students to experience learning that is both challenging and collaborative.

Develop Stage: The feasibility of the products, including the teaching module, learning media, and student worksheets, was rated "Excellent" based on SBi analysis, with feasibility scores of 88.87 percent, 94.05 percent, and 91.67 percent respectively. The validity of the conceptual understanding test and self-efficacy questionnaire was examined using Aiken's V, with average values above 0.9, indicating high validity. Empirical validity analyzed using the Rasch model in JAMOVI confirmed that all 20 pretest and posttest items on conceptual understanding were valid, and 12 out of 15 self-efficacy questionnaire items were also valid. Reliability tests showed high results for the conceptual understanding test (KR-20 values of 0.642 and 0.733) and the self-efficacy questionnaire (Cronbach's alpha of 0.770).

Disseminate Stage: This stage involved dissemination and follow-up activities. The researcher shared the product with physics teachers at the research site as part of continued collaboration and the exchange of good practices. In addition, the results of the development were published in a scientific article.

Students' responses to the GBL Escape Room model were highly positive. The overall mean score reached 3.6 or 90 percent, which falls into the "Excellent" category. Aspects such as material relevance, media attractiveness, and collaboration also received very positive responses with scores above 89 percent.

The effectiveness of the GBL Escape Room model was measured by comparing pretest and posttest scores between the experimental class and the two comparison classes.

Table 2. Manova Test

Source	Pillai's Trace	p
(Intercept)	0.986	<.001
Class	0.573	<.001

There was a significant multivariate effect of the class treatment on the combined variables of conceptual understanding and self-efficacy. Pillai's Trace value indicated that 57.3 percent of the variance in the combined variables was explained by differences in treatment.

Table 3. Anova test of Concept Understanding

Variabel	F	p	ω^2
Conceptual Understanding	32.217	<.001	0,380

There were significant differences between the classes. The omega squared value (ω^2) of 0.380 indicated a large effect size, meaning that 38 percent of the variance in scores was influenced by the treatment.

Table 4. Post Hoc Self efficacy

Group	Cohen's d	p
Experiment-Contrast 1	1.049	<.001
Experiment-Contrast 2	1.945	<.001
Contrast 1 – Contrast 2	0.896	0.001

A significant difference was found between the experimental class and both comparison classes, as reflected in the results.

Table 3. Anova Test of Self efficacy

Variabel	F	p	ω^2
Conceptual Understanding	38.929	<.001	0,427

There were also significant differences across classes for the self-efficacy variable. The omega squared value (ω^2) of 0.427 showed a large effect size, indicating that 42.7 percent of the variance in scores was influenced by the treatment.

Table 4. Post Hoc Self efficacy

Group	Cohen's d	p
Experiment-Contrast 1	1.425	<.001
Experiment-Contrast 2	2.095	<.001
Contrast 1 – Contrast 2	0.670	0.018

The experimental class differed significantly from both comparison classes, and the effect size demonstrated a very strong influence of the treatment.

Discussion

This study successfully developed a GBL model assisted by an Escape Room that proved to be both effective and practical. The high level of product feasibility, indicated by expert validation scores above 88 percent, confirms that the learning media meet strong substantive, didactic, and technical standards. The rigor of the validation process, which involved the use of Aiken's V and the Rasch model, ensures the reliability of the instruments used to measure the variables.

The practicality of the model was supported by students' positive responses, with 90 percent falling into the "Excellent" category. This finding is consistent with previous studies showing that GBL and Escape Room approaches can enhance student engagement, motivation, and collaboration (Rahmi et al., 2020).

The inferential analysis strongly demonstrated the effectiveness of the GBL Escape Room model. The significant multivariate and univariate effects, along with the large effect sizes for both variables (conceptual understanding and self-efficacy), indicate that the model impacts not only cognitive outcomes but also affective ones. The consistent improvements observed in the experimental class, compared with stagnation or decline in the control classes, further highlight the superiority of this model over conventional learning approaches. These findings are in line with the study by Chang et al. (2024), which also reported higher learning achievement among groups using Escape Room activities.

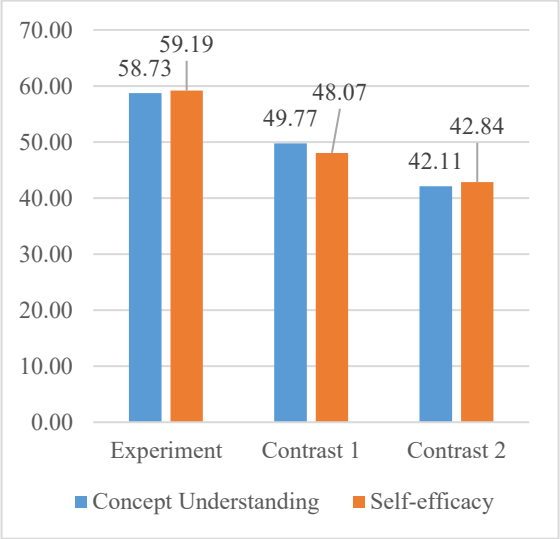

Figure 1. The Difference between Group

CONCLUSION

Based on the findings, it can be concluded that the GBL model assisted by an Escape Room emphasizes the integration of game elements, collaboration, and strong conceptual understanding. The model was designed to create a learning atmosphere that is both enjoyable and meaningful. It was deemed feasible based on expert validation of the content, media, and instructional design, with average scores falling into the "highly appropriate" category.

There was an improvement in students' conceptual understanding and self-efficacy after participating in learning activities using the GBL Escape Room model. The model was proven effective in enhancing these two variables, as indicated by significant statistical results and clear differences between the experimental and conventional groups. The product also demonstrated a high level of practicality, supported by positive responses from both teachers and students regarding its implementation and ease of use.

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