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# CONNECTING GAMIFIED CONTEXTUAL LEARNING WITH EDUCATIONAL OUTCOMES: THE CASE OF THE ADVENTURE OF RINJANI

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## ABSTRACT

This article investigates the pedagogical potential of the Adventure of Rinjani. These gamified contextualized science learning media are intentionally created to support the development of students' science literacy, creativity, achievement motivation, and scientific attitude. In response to the growing demand for meaningful and engaging science education, this article presents a framework developed through a comprehensive literature review and an instructional design process guided by the Dick and Carey model, which informs the game's creation. The Adventure of Rinjani game incorporates a contextual learning model, utilizing the REACT (Relating, Experiencing, Applying, Cooperating, Transferring) approach within its gameplay. The game features seven levels, each representing a distinct real ecosystem on Mount Rinjani. Before further testing and focusing on empirical implementation, this article emphasizes the design rationale, development process, and theoretical mapping of the game elements adopted in Adventure of Rinjani to the four targeted educational outcome variables. A narrative literature review is conducted to identify how gamification and contextualized learning influence each variable. The article concludes with a conceptual mind map that visually depicts the relationship between specific features of the Adventure of Rinjani and the four expected learning outcomes. This framework can serve as a foundation for future empirical research and as a reference for educators and developers who adopt or adapt contextualized learning media integrated with gamification for 21st-century science education.

**Keywords:** Gamification, Contextual Learning, Educational Outcome, Science Literacy, Creativity

## INTRODUCTION

In recent years, science education has faced growing challenges in fostering student engagement, conceptual understanding, and interest in real-world scientific issues. Various studies and classroom observations reveal that students often perceive science as abstract (Gunawan et al., 2015; Jufri et al., 2018), fragmented, and disconnected from their daily experiences (Cock et al., 2003). This disconnect is particularly evident in ecology and environmental education, where concepts such as ecosystems, food chains, and biodiversity may seem distant or irrelevant unless grounded in familiar, observable contexts. Traditional learning methods dominated by lectures (Teppo et al., 2021), textbook reading, and memorization often fail to spark curiosity or encourage deeper inquiry, resulting in low motivation and superficial learning outcomes. To address these challenges, educators and researchers have called for more innovative and student-centered approaches that make science more meaningful, experiential, and engaging. Two strategies that have gained more attention in this endeavor are contextualized learning and gamification.

The integration of e-learning platforms has been shown to improve student engagement and learning outcomes in digital communication systems (Kanth et al., 2019). Educational

innovations that integrate contextual learning with gamification have gained significant attention (Alsadoon et al., 2022; Su & Cheng; 2015). Contextualized learning connects scientific content to students' real lives, promoting relevance and application (Davtyan, 2014; Yager, 2000). Gamification incorporates game elements, such as points, badges, and interactive challenges, into educational environments to increase engagement and motivation (Deterding et al., 2011; Kapp, 2012; Kam & Umar, 2018; Christopoulos & Mystakidis, 2023). Recent studies have shown that gamified learning environments can significantly improve student motivation and learning outcomes in science education (Gulhane, 2024; Kalogiannaki et al., 2021; Delgado-Algarra, 2022). Gamification, through the integration of game elements such as exploration, challenge, feedback, and narrative, has been shown to increase student engagement, autonomy, and motivation (Alsadoon et al., 2022; Su & Cheng, 2015). Moreover, integrating gamification into environmental education has shown promise for promoting pro-environmental behavior and a deeper understanding of ecological concepts (Tan & Nurul-Asna, 2023). By utilizing game-based learning strategies, educators can create immersive experiences that not only convey scientific knowledge but also encourage critical thinking and problem-solving skills essential for addressing environmental challenges. Combined, contextualized learning with gamification offers a powerful way to transform science education into an immersive, meaningful, and motivating experience.

This article introduces Adventure of Rinjani, a game-based contextual science learning media explicitly developed to support and improve four essential learning outcomes in students: science literacy, creativity, achievement motivation, and scientific attitude. The Adventure of Rinjani was designed to meet the need for more in-depth, meaningful science teaching that aligns with students' real-world experiences and encourages active learning. At its core, Adventure of Rinjani leverages the educational potential of gamification to make abstract scientific concepts more concrete, understandable, and engaging. Structured into seven sequential levels, each stage of the game represents a distinct ecosystem found along Mount Rinjani, ranging from lowland forests to mountain peaks. The ecosystems in the game serve not only as a backdrop but also as the center of a contextual framework to deliver science content aligned with the Merdeka Curriculum in Indonesia for Primary School Grade V, specifically the IPAS Chapter Harmony in Ecosystems. As students progress through the game, they will encounter a variety of tasks, including interactive reading materials, short formative quizzes, and missions to collect flora and fauna. These tasks are carefully designed to encourage observation, reasoning, and problem-solving in ways that mimic scientific inquiry.

Adventure of Rinjani adopts a contextual learning model with the REACT (Relating, Experiencing, Applying, Cooperating, Transferring) approach as its instructional backbone (Crawford, 2001). Each stage of the game reflects one or more components of the REACT approach, for example, relating new knowledge to familiar experiences through environmental storytelling, applying content through decision-making tasks, or transferring understanding through reflection at the end of each level. The presence of a mountaineering guide character (named Ali) further enriches the narrative and provides ongoing scaffolding, reflection prompts, and motivational support. As a result, Adventure of Rinjani not only delivers science

content but also encourages the development of higher-order thinking skills and positive learning dispositions in a dynamic and fun way.

However, despite these promising directions, notable gaps remain in the literature. First, few studies have explicitly integrated gamification with contextual models such as REACT in the design of elementary science media. Additionally, the theoretical mapping between game mechanics and targeted learning outcomes is often lacking or underreported. There is also limited development of gamified media tailored to the Indonesian curriculum context, particularly one grounded in real ecological settings such as Mount Rinjani. Moreover, early-stage design-based research that emphasizes the conceptual foundation and instructional logic of gamified learning tools is rarely documented in detail. Lastly, affective outcomes, such as scientific attitude and motivation, remain underexplored in game-based learning environments. These gaps underscore the need for research that bridges theory, design, and local curriculum needs in a structured and meaningful way.

This article describes the development process of the Adventure of Rinjani. It presents a review of relevant literature, culminating in a theoretical mind map that visualizes the potential impact of the Adventure of Rinjani game design on four targeted educational outcome variables. Although the implementation and summative evaluation phases are planned for future research (after this), this article provides a conceptual foundation for understanding how gamified contextualized media can be systematically designed to support science learning in meaningful and motivating ways.

## LITERATURE REVIEW

### A. Gamification in Education

Gamification refers to the use of game design elements in non-game contexts to increase user engagement and motivation (Deterding et al., 2011). In educational settings, gamification includes mechanisms such as points, levels, badges, challenges, progress tracking, and narrative elements to encourage active learning. A growing body of research supports its effectiveness in increasing learners' intrinsic motivation, participation, and academic performance (Alsadoon et al., 2022; Hamari et al., 2014; Hu, 2020). In science education, gamified environments have been shown to create emotionally engaging experiences that foster curiosity and perseverance (Deterding et al., 2011; Werbach & Hunter, 2012). Studies show that gamification can personalize the learning experience and encourage a mastery-oriented mindset by providing immediate feedback and allowing learners to learn progressively at their own pace (Su & Cheng, 2015). However, researchers also caution that gamification must be carefully designed to ensure that learning objectives are not overshadowed by gameplay and that students remain focused on understanding rather than solely on earning rewards (Koivisto & Hamari, 2019). Insights from this body of literature have informed decisions in designing Adventure of Rinjani, specifically in aligning game elements that motivate students to achieve learning objectives. These findings serve as a theoretical foundation for mapping specific game mechanics to the development of cognitive and affective learning outcomes.

B. Contextual Learning and The REACT Approach

Contextual learning is an educational strategy that emphasizes the connection between academic content and real-life situations. This strategy aims to make learning meaningful by embedding concepts in authentic and relevant everyday experiences that are meaningful to students' lives. The contextual learning model is a holistic learning process that aims to help students understand the meaning of teaching materials and relate them to the contexts of their daily lives (personal, social, and cultural) (Davtyan, 2014), so that students have dynamic and flexible knowledge/skills to construct their understanding actively. Contextual learning in learning is recognized as a reasonable approach and is expected to improve students' science learning outcomes (Rowan et al., 2002; Maphoso & Mahlo, 2015; Neftyan et al., 2018; El Islami et al., 2018; Ott et al., 2018; Fu & Hwang, 2018; Parmin et al., 2022; Antony & Elangkumara, 2020; Mnguni et al., 2020). In science education, contextualized learning plays a vital role in bridging the gap between theoretical knowledge and practical understanding, particularly in complex topics such as ecosystems, environmental issues, and sustainability (Crawford, 2001). One widely known approach that operationalizes contextual learning is the REACT approach, which stands for Relating, Experiencing, Applying, Cooperating, and Transferring.

Each REACT component is designed to encourage deeper student engagement and realize meaningful learning. Relating involves connecting new concepts with students' previous experiences and backgrounds. Experiencing involves engaging students in simulated or hands-on real-world activities. Applying encourages the use of newly acquired knowledge in practical situations or problem-solving. Cooperation promotes collaboration and social interaction in the learning process. Transferring helps students generalize and apply their knowledge across multiple contexts or disciplines. Several studies have confirmed the effectiveness of contextual learning in increasing student motivation, improving concept retention, and developing critical thinking skills (Kadmayana et al., 2021; Rahmawati & Ika, 2019; Dewi et al., 2018; Johnson, 2002). These findings directly inform the integration of REACT principles into the Adventure of Rinjani learning flow, guiding the creation of tasks that simulate meaningful real-world experiences.

C. Science Literacy

Science literacy is an essential competency in the 21st century, enabling individuals to make informed decisions about personal and social issues based on scientific evidence. Science literacy encompasses not only knowledge of scientific concepts and processes but also the ability to apply, interpret, and critically evaluate scientific information in various contexts. According to the Program for International Student Assessment (PISA), science literacy encompasses the ability to explain phenomena scientifically, evaluate and design scientific investigations, and interpret data and evidence in a scientific context (Pisa, 2019). Today, science literacy is at the forefront of contemporary education (Laugksch, 2000; Levinson, 2010), civic engagement (Greenhow et al., 2015; Rudolph & Horibe, 2016; Brouwer & Hessels, 2019), and cultural dynamics (Bonney et al., 2009; Van Eijck & Roth, 2010). The development of science literacy is crucial in preparing students for real-world challenges, such

as climate change, health crises, and environmental sustainability (Li & Guo, 2021; Steinwachs & Martens, 2022; Mohd Nor & Mahmud, 2024). However, traditional science teaching often emphasizes memorizing facts over critical thinking and application, thereby limiting students' ability to use science meaningfully in their lives.

Educational innovations, such as gamification and contextualized learning, offer promising pathways to enhance science literacy. Gamified learning environments offer students authentic problem-solving tasks and interactive simulations, thereby enhancing engagement and understanding (Delgado-Algarra, 2022; Parks, 2019; Zourmpakis et al., 2023; Jaramillo-Mediavilla et al., 2024). Similarly, contextualized learning helps students connect scientific knowledge to their immediate environment, thereby deepening their understanding and increasing relevance. When combined, these approaches support the development of scientific reasoning, argumentation, and evidence-based decision-making. The design of the Adventure of Rinjani aligns with these theoretical insights, with each game element aimed at strengthening students' ability to apply scientific concepts in a realistic and engaging context. Thus, the literature supports the conceptual framework developed in this study.

D. Creativity

Creativity is increasingly recognized as a fundamental skill in 21st-century education (Martinez, 2007; Simonton, 2006; Scholte, 2008; Alencar & Fleith, 2010; Hennessey & Amabile, 2010), particularly in science learning, where students are expected to explore problems, generate innovative solutions, and think beyond conventional boundaries (Feist & Gorman, 1998; Kaufman, 2002). Creativity is defined as the ability to produce new and appropriate work in a particular context (Runco & Jaeger, 2012) and includes key dimensions such as fluency, flexibility, originality, and elaboration (Torrance, 1966). Creativity refers to the ability that characterizes a creative person (Guilford, 1970) to produce new compositions and ideas that can take the form of imaginative or synthesizing activities that involve forming patterns and combinations from past experiences linked to current situations (Hurlock, 1978). Creativity is closely related to inquiry-based learning, as scientific creativity involves asking questions, hypothesizing, designing experiments, and interpreting results meaningfully.

Educational environments that encourage exploration, experimentation, and autonomy are crucial for fostering creativity (Alencar & Fleith, 2010; Fleith & Alencar, 2010; Wechsler & Souza, 2011). Gamification-based learning, especially when designed with open-ended tasks and interactive narratives, offers students the opportunity to engage in divergent thinking and creative problem solving. Recent research shows that games in learning can significantly enhance students' creativity by engaging them in dynamic, decision-rich environments that stimulate innovative thinking and exploration (Li & Li, 2024; Behnamnia et al., 2020; Kalinauskas, 2014; Ricoy, M. C., & Sánchez-Martínez, 2022). Contextualized learning also contributes to creativity by grounding scientific problems in real-life situations, requiring students to relate content to everyday experiences and thereby stimulating creative reasoning and problem-solving (Sian et al., 2024). The conceptualization of Rinjani's Adventure incorporates these principles to foster creativity and innovation. The game's features, including exploration, narrative flexibility, and open-ended tasks, are directly informed by the literature

and integrated into the mind map framework as creativity developers.

E. Achievement Motivation

Achievement motivation refers to an individual's internal drive to achieve goals (McClelland, 1961; Amabile,1996), overcome challenges (Deci & Ryan, 2012; Duckworth et al., 2007), and achieve a sense of competence and success (Atkinson, 1981; Emmons, 1986). In an educational context, achievement motivation is an essential affective factor that influences how students perform on tasks, persist in the face of adversity, and feel rewarded for their academic efforts. Rooted in the work of McClelland (1961), achievement motivation is often characterized by the desire to master, improve, and develop oneself, rather than by the pursuit of external rewards. Motivation theories, such as Self-Determination Theory (SDT), highlight the importance of intrinsic motivation —i.e., the motivation to engage in an activity for its own sake— as a predictor of long-term academic success (Ryan & Deci, 2000). Key elements that foster intrinsic motivation, including autonomy, competence, and relatedness, can be activated through careful instructional design. In this regard, gamification has demonstrated strong potential to enhance achievement motivation by offering goal setting, instant feedback, progress tracking, and meaningful challenges (Alsadoon et al., 2022; Su & Cheng, 2015; Dichev & Dicheva, 2017; Ghosh & Pramanik, 2023). Gamified learning environments encourage students to set personal goals, make choices, and persist in completing tasks to unlock new levels or rewards. This experience supports the development of self-regulation and a sense of accomplishment, especially when learners experience gradual success through incremental challenges. Furthermore, contextualized learning strengthens achievement motivation by framing content in personally meaningful, socially relevant scenarios for the learner (Gulhane, 2024). These motivational principles heavily influenced the design of the Adventure of Rinjani. The literature provides a framework for designing game elements that support internal goal-setting, autonomy, and reflection on progress, as mapped out in a conceptual mind map.

F. Scientific Attitude

Scientific attitudes encompass a set of dispositions and values that guide individuals' approach to scientific inquiry, decision-making, and problem-solving. These attitudes include curiosity, open-mindedness, respect for evidence, objectivity, critical thinking, and willingness to change one's views based on new data (Gauld & Hukins, 1980; Lederman, 1992; Murugan, 2019; Chakraborty & Gogoi, 2014; Gardner, 1975; Osborne et al., 2003). Cultivating scientific attitudes is essential in education as it supports the development of students' ability to reason, analyze phenomena logically, and engage ethically in scientific practices (Lederman, 1992; Osborne et al., 2003; Germann, 1988; Jarvis & Pell, 2005).

Several studies have shown that a decisive factor in determining students' attitudes towards science is the classroom learning environment (Lawrenz, 1976; Simpson & Oliver, 1990; Hunus & Fraser, (1997). This implies that the science learning environment correlates with students' attitudes towards science. Traditional classroom practices, which often emphasize memorization of content, may not adequately support the development of scientific attitudes (Oh & Yager, 2004). In contrast, learning environments that emphasize exploration,

inquiry, and reflection can significantly improve students' attitudes towards science. Contextualized learning approaches, especially those that immerse students in real-world environmental issues, have been shown to foster scientific values and awareness of the human-nature relationship (Dewi, 2018). Gamification also contributes to the development of scientific attitudes by framing learning as a journey of discovery, in which challenges encourage inquiry and problem-solving, thereby making the exploration of material more engaging and meaningful for students (McCarthy, 2021). Research indicates that gamified learning environments can significantly enhance student engagement and motivation, offering a suitable platform for developing key aspects of scientific attitudes (Mao et al., 2022). Well-designed educational games can effectively engage students, encouraging them to question, hypothesize, and revise their ideas through immersive experiences. In addition, narrative elements in gamified learning, such as character guidance or storytelling, can encourage students to reflect on the moral and ecological implications of scientific issues (Tan & Nurul-Asna, 2023). These insights are embedded in the Adventure of Rinjani through game elements designed to encourage curiosity, inquiry, and reflective exploration—theoretical foundations from the literature support mapping the development of scientific attitudes in a mind map framework.

## METHODE

A. Research Design: Development and Literature-based Analysis

This study adopts a development research approach, specifically an early-stage design-based research (DBR) methodology focused on the analysis, design, and theoretical justification of the *Adventure of Rinjani* gamified contextual learning media. Before presenting the empirical implementation results, this article emphasizes the conceptual development of the media and the theoretical mapping of its game elements to the four targeted learning outcome variables: science literacy, creativity, achievement motivation, and scientific attitude. In line with Type I development research (Richey & Klein, 2007), this study highlights the systematic design process and theoretical framework of the learning media. A narrative literature review was conducted to identify key findings from prior research on gamification, contextualized learning, and the four targeted learning outcome variables. These findings were synthesized into a conceptual mind map illustrating the relationship between specific game features and the desired educational objectives.

B. Development Framework: Dick and Carey's Learning Design Model

The development *of the Adventure of Rinjani* adapts the systematic stages of the Dick and Carey learning design model (Dick et al., 2005), which is widely used in educational technology and curriculum design. This model includes the following ten steps: 1) Identifying learning objectives. 2) Conducting a learning analysis. 3) Analyzing learners and context. 4) Writing performance objectives. 5) Developing assessment instruments. 6) Developing learning strategies. 7) Developing and selecting learning materials. 8) Literature-Based Design Analysis. 9) Designing and conducting formative evaluations. 10) Conduct a summative evaluation. This study focused on completing steps 1-8, culminating in an enhanced version of the media based on literature-based design strategies. Formative and summative evaluations

are planned for future work, including empirical testing in classroom settings to evaluate the effectiveness of the game media.

C. Theoretical Learning Approach: REACT Model

The learning content and task structure *of the Adventure of Rinjani* are based on the contextual learning model with the REACT approach, which includes five instructional components. 1) Relating: Students connect science content to their life experiences through environmental scenarios. 2) Experiencing: Interactive tasks simulate exploration and investigation of real-world ecosystems. 3) Applying: Students solve ecological problems based on content knowledge. 4) Cooperating: Narrative and task design encourage collaborative learning and reflection. 5) Transferring: Students are encouraged to generalize what they learn to a broader environmental context. The REACT framework is used to ensure that all elements of the game have a meaningful instructional purpose.

D. Data Sources and Analysis

This research used two primary data sources:

- Documentation and artifacts produced during the media development process, including design plans, level blueprints, character interactions, and in-game tasks.
- Literature synthesis involved a thematic analysis of scientific studies related to gamification, contextualized learning, and the four learning outcomes. These findings were coded and mapped to the corresponding game features. The resulting conceptual framework is presented as a visual mind map and serves as the main output of this research.

E. Research Outputs: Theoretical Mapping and Framework Mind Map

The main output of this article is a conceptual framework that visually connects the game elements in *Adventure of Rinjani* to the four targeted learning variables. The instructional design process and a comprehensive literature review inform this mapping. While summative evaluation and classroom implementation are planned for future research, this conceptual model can guide future empirical validation and instructional design initiatives involving gamified contextualized learning. The stages of research activities, based on the methodology, are presented in the following table.

**Table 1.** Research Stages and Outcomes Based on The Development Methodology

| Stage | Description | Main Outcome |
|---|---|---|
| 1. Identifying Learning Objectives | Defined instructional goals aligned with curriculum and ecosystem topics. | List of general and specific objectives for the learning media. |
| 2. Conducting a Learning Analysis | Analyzed subtopics related to "Harmony in Ecosystems" and their sequencing. | The learning task map is organized across seven levels of gameplay. |
| 3. Analyzing Learners and Context | Identified characteristics of 5th-grade elementary students and contextual environment. | Learner profile and game context analysis. |
| 4. Writing Performance Objectives | Converted general objectives into specific measurable competencies. | Set of performance objectives per level. |
| 5. Developing Assessment Instruments | Designed quizzes and in-game challenges aligned with objectives. | Question sets and game-based task blueprints. |

| | | |
|---|---|---|
| 6. Developing Learning Strategies | Applied the REACT contextual approach to guide task design and narrative. | Strategy matrix matching REACT components to game features. |
| 7. Developing and Selecting Learning Materials | Designed game content, character, map, flora-fauna encyclopedia, and UI layout. | Prototype of the "Adventure of Rinjani" game (Version 1). |
| 8. Literature-Based Design Analysis | Conducted thematic analysis of gamification and learning outcome literature. | Mind map showing the conceptual mapping between game elements and four learning variables. |

*Note. This study did not implement stages 9 and 10 (Formative and Summative Evaluation). Future research is planned to address these stages.*

A flowchart that aligns with the table above and excludes stages that have not yet been performed is presented below.


**Fig. 1.** Flowchart of the stages of the research conducted.

## RESULTS AND DISCUSSION

The development *of the Adventure of Rinjani* illustrates how game-based and contextualized learning strategies can be meaningfully integrated to support key educational outcomes. Implementing contextual models and ensuring user-friendly interfaces are crucial for the effectiveness of educational tools, as evidenced by studies on IoT systems and authentication mechanisms (Alani et al., 2020; Wiercioch et al., 2018). In an educational landscape increasingly focused on real-world engagement, motivation, and relevance, the game represents a deliberate attempt to translate pedagogical theory into immersive digital practice. The *Adventure of Rinjani* game is designed not only to deliver content but also to foster a

dynamic learning environment in which students engage with meaningful ecological scenarios through structured challenges and narrative exploration. Aligning the game elements with the instructional principles of the REACT approach, the contextual learning model, and the gamification literature, this article provides a theoretical foundation for a media product that is both engaging and instructionally rich. It reflects a holistic approach that supports cognitive, affective, and behavioral domains simultaneously through interconnected learning experiences grounded in curriculum standards and real-world environments.

The literature review highlighted strong empirical evidence supporting the use of gamified learning to improve science literacy, creativity, achievement motivation, and scientific attitudes. Meta-analyses and experimental studies have demonstrated that game-based learning environments can foster deep engagement and conceptual understanding in science by creating student-centered, interactive tasks (Wang, 2022). Gamification mechanisms, such as narrative immersion, progress tracking, and authentic problem-solving, align with cognitive science principles that enhance knowledge retention and transfer (Koivisto & Hamari, 2019). Narrative-based exploration and task variety have been identified as powerful tools to stimulate curiosity, inquiry, and higher-order thinking. These elements provide learners with autonomy, challenge, and purpose, which are the key components of intrinsic motivation and metacognitive development (Ryan & Deci, 2000). In designing the *Adventure of Rinjani*, these insights were carefully considered. Each level of the game was created with tasks that balanced cognitive demands with motivational appeals, and each interaction was mapped to a specific instructional goal informed by contextual learning theory and the principles of gamification. In this way, the game design reflects a deliberate synthesis of evidence-based practices to enhance meaningful learning experiences.

The conceptual mind map presented in this article synthesizes these theoretical relationships into a structured and accessible format, illustrating how the game's diverse features contribute to various learning outcomes. Each element of the game, from level structure to narrative guidance, from quizzes to flora and fauna collections, is carefully aligned based on principles derived from the literature on gamification and contextual learning. For example, task-based progression is associated with achievement motivation, while explorative tasks are designed to foster curiosity and creativity. This visual framework is becoming an effective tool in instructional design and educational research, offering a comprehensive overview that helps practitioners understand the logic behind design choices (Behnamnia et al., 2020). Mind maps are invaluable for highlighting overlapping mechanisms and illustrating how a single game element can simultaneously influence multiple outcomes, such as scientific attitudes, engagement, and cognitive reflection (Cahyana et al., 2025). This visual framework is organized practically to illustrate how thoughtful game design can support multiple educational goals simultaneously, thereby enabling a more straightforward path for educators and developers to replicate or adapt such designs for their teaching purposes.

The analysis of game mechanics and educational objectives reveals the unique, interrelated ways in which the presence of learning media can influence students in some of the highlighted learning outcome variables. The theoretical mapping developed through this

research is presented as a conceptual mind map in Fig. 2. The mind map illustrates the theoretical framework linking specific game elements *of the Adventure of Rinjani* to the four targeted learning outcomes: science literacy, creativity, achievement motivation, and scientific attitude. Each branch in the mind map represents a key game element (such as level-based progression, narrative guidance by the character Ali, formative quizzes, and flora and fauna collection) and visually illustrates how it contributes to one or more learning outcomes.

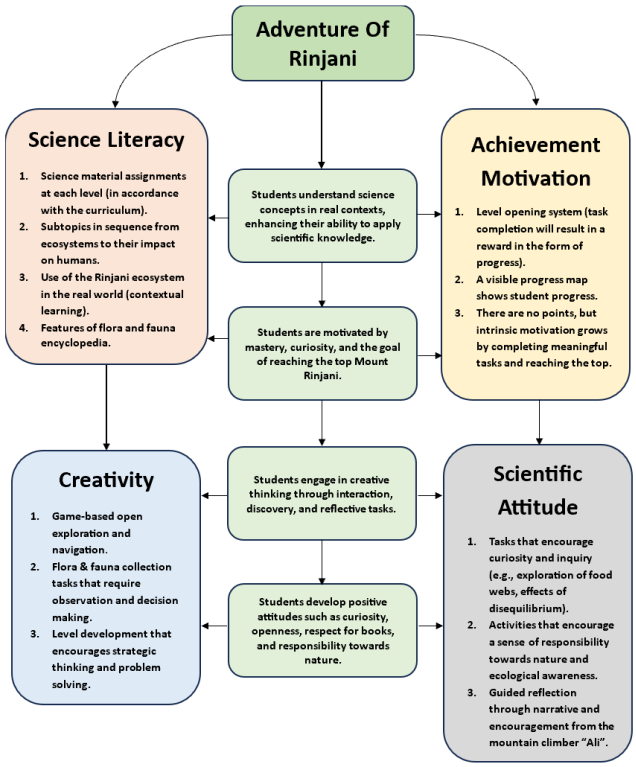


**Fig. 2.** Conceptual Mind Map of Game Elements and Research Variables in Adventure of Rinjani.

For example, the level progression is linked to science literacy and achievement motivation by providing structured learning aligned with curriculum subtopics and offering a sense of achievement upon completion of each stage. The narrative element, guided by mountaineer Ali, fosters scientific attitudes and creativity through story-based inquiry prompts and reflective learning. The Flora-Fauna Encyclopedia task supports science literacy and creativity by encouraging the contextual exploration and classification of biodiversity. At the same time, the embedded quiz serves as a formative assessment to reinforce conceptual understanding and self-regulated learning. Overlapping lines connecting multiple variables illustrate the multidimensional nature of game design, highlighting how a single element can support multiple educational outcomes simultaneously. This visual model summarizes the pedagogical rationale for developing the medium and serves as a practical guide for educators, curriculum designers, and researchers interested in implementing or adapting gamified contextual learning environments in science education.

In more detail, the relationship between the four highlighted learning variables and the game elements in *Adventure of Rinjani* is explained as follows: first, for the science literacy

variable. *The Adventure of Rinjani is organized around ecosystem-based topics that align* with science curriculum standards. The game elements that support the improvement of this variable are as follows. 1) Curriculum-aligned tasks. Science literacy is enhanced through structured, curriculum-aligned tasks that guide students across subtopics in ecosystem science. Each level contains material-based tasks rooted in science curriculum content, focused explicitly on the subtopic of ecosystems and their impact on humans. 2) Contextual exploration: Students engage with real-world applications of science by exploring the ecosystem of Mount Rinjani, enhancing their understanding of food chains, food webs, and environmental balance. Each level in *Adventure of Rinjani* presents a real-world ecological scenario that allows learners to investigate food chains, food webs, food pyramids, population relationships, and the role of humans in maintaining ecosystem balance. These inquiry-based and situational learning experiences develop students' capacity to interpret data, reason scientifically, and apply core concepts across contexts. This finding aligns with Wang (2022), who emphasized that game-based learning environments provide authentic contexts that enhance scientific understanding and foster practical science skills. Additionally, Fatih et al. (2024) demonstrated that reality-based science learning games significantly improved students' science literacy and critical thinking. 3) Scientific application: Flora and fauna collection tasks and reflective prompts help students apply scientific knowledge and reasoning in meaningful contexts. Exploration tasks allow students to interpret data and reason scientifically. This finding aligns with Widiyatmoko's et al. (2023) research, which revealed that virtual reality games enhance STEM literacy, particularly when centered on energy and ecology concepts. Similarly, Vilanueva (2024) emphasized that educational games can improve student performance in earth and life sciences through interactive exploration and situational learning. Game-based learning environments provide an authentic context that enhances scientific understanding and enables the development of practical science skills.

Second, for the creativity variable. The game elements in *Adventure of Rinjani* that support the improvement of this variable are as follows. 1) Open exploration and navigation. Creativity is fostered by providing students with open navigation and flexible problem-solving opportunities throughout the game. *The Adventure of Rinjani allows for* free movement and decision-making, encouraging students to discover content and strategies through personal exploration. According to Li & Li (2024), digital game-based learning supports creativity by engaging students in nonlinear decision-making tasks that simulate complex real-world situations requiring imaginative responses. The design encourages autonomy and divergent thinking through exploration, adaptive response, and personalized decision-making. 2) Strategic level development. Each level in the *Adventure of Rinjani* presents unique challenges that encourage flexibility, originality, and elaboration —core components of creative thinking. This leveling scheme is designed to develop students' problem-solving and strategic thinking skills while completing missions and to stimulate flexible, original responses from students. Behnamnia et al. (2020) also emphasized that interactive digital media, especially those that incorporate games and simulations, nurture students' creative potential by allowing them to visualize, design, and test their problem-solving approaches. 3) Creative expression through

tasks. The task of completing the flora and fauna encyclopedia required observational skills and personal decision-making, further fostering creativity.

Third, for the achievement motivation variable. The game elements in *Adventure of Rinjani* that support the improvement of this variable are as follows. 1) Intrinsic motivation elements. In *Adventure of Rinjani*, achievement motivation is reinforced through intrinsic game goals, such as the symbolic achievement of reaching the summit of Mount Rinjani, along with visual progress indicators, feedback cycles, and task-based progress. These features support students' self-regulation and persistence, providing a sense of competence and progress that sustains their motivation. Although there are no points, motivation is built through meaningful task completion, a progression system, and the overarching goal of reaching the summit. According to Gulhane (2024), a game-based environment with well-defined, gradually increasing challenges can stimulate students' desire to achieve, support a mastery-oriented mindset, and promote sustained effort. 2) Progress maps & milestones. Visible progress maps reinforce students' sense of accomplishment and autonomy. Dicheva et al. (2015) and Hamari et al. (2016) highlight how game elements such as immediate feedback, progress indicators, and reward systems can significantly improve motivation and learning outcomes. 3) Narrative encouragement. The presence of a mentor character (Ali) provides narrative support, motivating students to persevere and complete challenges. The opening of game levels, narrative support, and visual progress indicators encourage perseverance and autonomy. Research by Zhang & Yu (2022), Camacho-Sánchez (2024), and Chen & Tu (2021) supports the idea that well-structured gamification can promote sustained motivation for learning through self-regulation and cognitive engagement.

Fourth, the scientific attitude variable. The game elements in *Adventure of Rinjani* that support the improvement of this variable are as follows. 1) Inquiry and curiosity tasks. Students explore ecological phenomena, such as food webs and environmental disturbances, and are encouraged to question and make critical observations. 2) Narrative-based reflection. Reflection is guided through storyline elements that promote openness, responsibility, and ethical engagement with the natural world. 3) Respect and responsibility. Interacting with flora and fauna encourages respect for biodiversity and ecological awareness, strengthening environmental ethics. Inquiry—based exploration and reflection foster values such as curiosity, openness to evidence, and environmental responsibility. In *Adventure of Rinjani*, scientific attitudes are developed through in-game inquiry tasks, environmental storytelling, and the character Ali's (the climbing guide in the game) reflective guidance. These features are designed to foster habits of curiosity, objectivity, respect for evidence, and openness to revision, which are hallmarks of scientific thinking. Players are encouraged to observe, question, hypothesize, and draw conclusions about ecosystem dynamics as they interact with various environmental phenomena. Tan & Nurul-Asna (2023) highlighted the value of narrative-rich serious games in fostering ecological awareness, ethical reflection, and the development of scientific dispositions that go beyond classroom learning. Dewi et al. (2018) also found that contextualized science modules that emphasize real-world exploration and reflective learning foster stronger scientific attitudes, especially when paired with

environmental themes. Much earlier, Lederman (1992) noted that experiences based on scientific inquiry and the principles of the nature of science help students internalize the behaviors and values of scientists. This process is reinforced through inquiry-driven interactive games such as *Adventure of Rinjani*.

Each variable was associated with different and overlapping game elements, reinforcing the multidimensional impact of gamification in contextualized science learning. These overlapping mechanisms underscore how a single feature, such as narrative deepening or task variation, can simultaneously impact multiple learning domains. For example, the exploration element not only builds content understanding (cognitive) but also fosters curiosity (affective) and autonomy (behavioral). Similarly, reflective prompts embedded in narrative feedback enhance metacognitive awareness and stimulate ethical thinking in scientific inquiry. These linkages demonstrate how well-designed educational games can transcend single-domain outcomes, allowing learners to engage cognitively through problem-solving and conceptual understanding, affectively through emotional investment and curiosity, and behaviorally through actions such as task completion, cooperation, and self-directed exploration. These domain dependencies reinforce the argument made by Fu & Hwang (2018), who state that game-based learning environments should be intentionally designed to integrate content mastery with motivational and reflective experiences.

The interplay between these domains is critical in science education, where real-world relevance, environmental awareness, and ethical considerations often intersect. Holistic designs, such as the Adventure of Rinjani, align with contemporary frameworks for 21st-century learning, emphasizing critical thinking, self-regulation, collaboration, and sustainability. By encouraging these rich learning experiences, *Adventure of Rinjani* demonstrates how gamification and contextual learning can work together to prepare students for complex interdisciplinary challenges. As students progress through the game's levels, their motivation, reflection, inquiry, and engagement develop in tandem, aligning with research emphasizing the need for integrated educational experiences in the 21st century (Tan & Nurul-Asna, 2023; Fu & Hwang, 2018; Behnamnia et al., 2020; Ryan & Deci, 2000). In addition, the use of the Dick and Carey model ensures a rigorous and systematic development process, providing a structured path for identifying learning objectives, analyzing learner needs, crafting performance objectives, and designing valid assessments. The model facilitates a step-by-step instructional design that emphasizes alignment between content, strategy, and media components, ensuring pedagogical coherence throughout the development process. At the same time, the contextual learning model, combined with the REACT approach, also helps embed relevance and real-world application at each stage of the game. Its five pillars — Connecting, Experiencing, Applying, Collaborating, and Transferring — are intentionally woven into each level *of the Adventure of Rinjani*, guiding how tasks are framed, how players interact with content, and how knowledge is connected to students' life experiences. Taken together, these design foundations provide the structure and flexibility that make *Adventure of Rinjani* a versatile tool for science learning across various instructional contexts. Dick and Carey's structured nature supports scalability and transferability, while REACT's contextualization

ensures local meaning and student engagement. The integration of theory, instructional design, and game mechanics culminates in a robust framework, represented by mind maps, that bridges academic rigor with creative engagement. This framework offers practical insights not only to future researchers seeking to validate the impact of games empirically but also to curriculum developers and instructional designers aiming to implement evidence-based, pedagogically sound gamified learning experiences.

## CONCLUSIONS AND RECOMMENDATIONS

This research introduces Adventure of Rinjani as a carefully designed, game-based, contextual science-learning media, developed using the Dick and Carey learning model and combined with the REACT learning approach. The Adventure of Rinjani integrates storytelling, environmental exploration, problem-solving, and reflective inquiry in ways that align with key instructional objectives and emerging best practices in digital science education. Before reporting implementation results, this article presents a comprehensive conceptual framework that maps game elements to four key learning variables: science literacy, creativity, achievement motivation, and scientific attitude. Supported by current research literature, the mind map presented in this article illustrates how specific game mechanics, including level progression, character guides, quizzes, and encyclopedia collections, can foster cognitive understanding, affective engagement, and behavioral development in science learning.

The mind map serves as a conceptual synthesis and instructional guide for designing a gamified science learning environment. The resulting mind map is not simply a visual summary, but a theoretical framework that can guide future implementation, evaluation, and refinement. The mind map provides a practical tool for educators and learning designers to align the gamified learning experience with the various learning objectives. Most importantly, this research contributes to a broader discourse on meaningful educational innovation, where gamification and contextualized learning can be aligned to support interdisciplinary thinking and lifelong learning skills. In the future, empirical studies are needed to test the framework's effectiveness in a classroom context, evaluate student learning outcomes, and refine Adventure of Rinjani based on user feedback. As environmental education and digital pedagogy become increasingly intertwined, tools like Adventure of Rinjani have the potential not only to teach science but also to inspire curiosity, responsibility, and creativity among students.

However, this study has certain limitations. First, it is limited to the conceptual development phase and does not include empirical classroom implementation or quantitative evaluation of learning outcomes. Therefore, the effectiveness of the Adventure of Rinjani media in real-world classroom settings remains to be tested. Additionally, the generalizability of the mind map framework may vary with contextual factors, such as student demographics, technological accessibility, and teacher facilitation. Future research should conduct empirical trials using experimental or quasi-experimental designs to evaluate the game's impact on science literacy, creativity, achievement motivation, and scientific attitude. It is also recommended to explore how different types of learners respond to the gamified contextual model, and how the design might be adapted for broader curricular applications or other science

topics beyond ecosystems.

Moreover, the growing use of intelligent systems and computational tools in education underscores the importance of integrating technological innovation into the design of learning media. For instance, Ganglberger et al. (2017) iscusses how machine learning can support complex data analysis in EEG classification. This example parallels how thoughtful digital design can enhance interaction, personalization, and real-time feedback in educational environments.

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