CHAPTER III
RESEARCH METHODOLOGY

3.1 Research Method

This study employs a Developmental Research methodology, incorporating a mixed-methods research design. The developmental research approach focuses on the systematic design, development, and evaluation of an instructional product (Richey & Klein, 2005), which directly aligns with the primary research objective of creating a simulation game. Within this framework, a mixed-methods design was utilized to gather and analyze both quantitative data (e.g., expert validation scores, student Likert scale responses) and qualitative data (e.g., expert comments, student interviews, and open-ended feedback). This combination provides a more comprehensive and robust evaluation of the product's validity and effectiveness than a single method could achieve alone. To guide the development process, this study utilizes the ADDIE model, which consists of Analysis, Design, Development, Implementation, and Evaluation and is widely recognized for its systematic and comprehensive approach to instructional design, ensuring that the final product is both effective and aligned with its intended learning goals (Branch, 2009).

3.2 Research Design: The ADDIE Framework

The development of the simulation game followed the five phases of the ADDIE model:

3.2.1 Analysis Phase

This initial phase focused on identifying the core needs and parameters for the project. Key activities included analyzing the existing curriculum for disaster mitigation, conducting a needs analysis to confirm the demand for an interactive learning tool, performing a user analysis to understand the target students' prior knowledge and digital skills, and assessing the software and hardware requirements for game development. The outcome of this phase was a clear set of learning objectives designed to facilitate students' scientific literacy in disaster preparedness.

3.2.2 Design Phase

In this phase, the simulation game is conceptualized and planned. The researcher created a storyline, flowchart, storyboard, and detailed game mechanics. Instructional strategies were determined, ensuring that the game integrates interactive learning experiences. The selection of media, visual assets, and sound effects is conducted to enhance engagement. Additionally, an implementation plan is designed, outlining how the simulation game would be integrated into the learning process.

3.2.3 Development Phase

The development phase involved the technical creation of the simulation game using the Construct 3 game engine. All components outlined in the design phase, including levels, interactive scenarios, characters, and scoring systems, were programmed and assembled. The prototype underwent iterative testing and validation by experts, with revisions made based on their feedback to improve content accuracy, usability, and technical stability.

3.2.4 Implementation Phase

During this phase, the validated game prototype was implemented in a real-world classroom setting with eighth-grade students. Students engaged with the game, and data regarding their experience and learning was collected through questionnaires and follow-up interviews. This phase served to test the game's practical application and gather user-centric data for final evaluation.

3.2.5 Evaluation Phase

Evaluation is conducted throughout the development process. Formative evaluation occurred in the analysis, design, and development phases, ensuring that each stage aligned with instructional goals. Summative evaluation is performed after implementation to measure the game's effectiveness in improving students’ scientific literacy. Operational evaluation involved ongoing assessments to refine and enhance the game based on teacher and student feedback. The ADDIE model diagram can be seen on Figure 3.1.

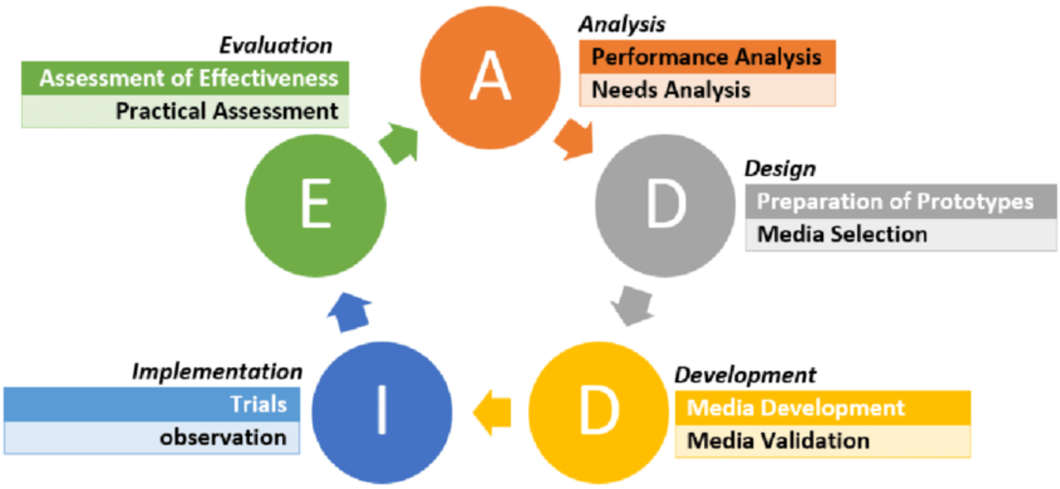

Figure 3. 1: ADDIE Model

3.3 Population and Sample

This study involved three distinct groups of participants: experts, a science teacher, and eighth-grade students.

Population: The target population for this research consists of eighth-grade junior high school students in Indonesia who have studied Earth science topics as part of their curriculum.

Expert Sample: The expert panel for product validation was selected using purposive sampling. The criteria for selection were expertise in science education, media development, or classroom pedagogy. The final panel consisted of four experts: three university lecturers in science education and one experienced junior high school science teacher.

Student Implementation Sample: For the main implementation phase, a sample of 62 eighth-grade students from a single junior high school was selected using convenience sampling. This method was chosen for its practicality due to accessibility and the willingness of the school and students to participate.

Student Interview Sample: From the implementation sample, nine students were selected for semi-structured interviews, also using purposive sampling. These students were chosen to represent a spectrum of responses (e.g., highly engaged, moderately engaged, and those who faced technical difficulties) to ensure a diverse range of qualitative insights.

3.4 Research Instruments

This study utilized three types of research instruments to collect data and address the research questions: Development Stage Instruments, Expert Judgment Questionnaire, and Student Response Questionnaire.

3.4.1 Instruments for Documenting the Development Process

To systematically document the development process and answer the first research question regarding the design and creation stages, a set of qualitative documentation tools were utilized:

Design and Storyboard Logs: These documents served as a comprehensive record of the pre-production and production phases. They included detailed storyboards for each scene, user flow diagrams, documentation of key design decisions, and logs of revisions made based on early feedback.

Technical Development Log: A specific log was maintained to chronicle the programming and asset implementation progress within the Construct 3 engine. This record included notes on implemented features, bug tracking and resolution, and version control.

Researcher's Reflective Diary: A personal journal was kept throughout the project to capture critical reflections, challenges encountered, solutions implemented, and feedback received from supervisors. This diary provides a rich, narrative account of the entire ADDIE cycle from the researcher's perspective.

3.4.2 Instrument for Expert Judgment

To assess the content and media validity of the game, a questionnaire was administered to the expert panel. The instrument used a 5-point Likert scale and was designed to evaluate four key indicators: Content Suitability, User Experience, Visual Appeal, and Technical Quality. The instrument also included an open-ended comment section for qualitative feedback. The Expert Judgment Questionnaire can be seen on Table 3.1.

Table 3.1 Expert Judgment Questionnaire

Indicator	Assessment Statement	1	2	3	4	5
Content Suitability	The content is aligned with disaster mitigation concepts in the curriculum.					
	The content is accurate, up-to-date, and relevant to students' context.					
	The depth of content supports comprehension and higher-order thinking.					
	The game encourages students to analyze and apply science in the context of disaster.					
	The game presents real-life problems and solutions related to disaster mitigation.					
User Experience	The flow of gameplay is coherent and easy to follow.					
	The game presents interactive and engaging content.					
	The navigation, buttons, and features are intuitive and user-friendly.					

Visual Appeal	The visual design is consistent with the disaster mitigation theme.					
	The use of colors and layout attracts attention and supports readability.					
	The balance between visual creativity and functionality is well maintained.					
Technical Quality	Text and images are clear and high-resolution.					
	The font size and type are appropriate for educational purposes and readability.					
	The game runs smoothly with no significant bugs or errors.					
Comments:						

3.4.3 Instruments for Student Response

To measure student responses, a mixed-methods approach was used, combining a quantitative questionnaire with qualitative data collection tools.

Student Questionnaire: A questionnaire using a 5-point Likert scale was developed to assess students' perceptions of the game. It covered indicators such as Content Suitability, Motivation and Engagement, and Visual Quality. To establish its reliability, an internal consistency analysis on the data from 62 students yielded a Cronbach's Alpha coefficient of 0.89, indicating a high degree of reliability. It is noted, however, that this self-developed instrument did not undergo a separate statistical validation for construct validity; this limitation was mitigated by triangulating the findings with qualitative data. The student response questionnaire can be seen on Table 3.2.

Open-Ended Comments: The questionnaire included a final question inviting students to provide written feedback.

Semi-Structured Interview Guide: An interview guide was used for the interviews with nine students to ensure key topics were covered while allowing flexibility for deeper probing. The guide focused on general impressions, likes/dislikes, difficulties, and learning takeaways.

Table 3. 2 Student Questionnaire

Indicator	Assessment Statement	1	2	3	4	5
Content Suitability	The game content helps me understand the concept of earthquake disaster mitigation.					
	The game helps me relate science concepts to real-life disaster situations.					
	I can understand the importance of disaster preparedness after playing the game.					
	The game helps me realize what actions I should take in case of an earthquake.					
	The learning experience in this game makes me more confident in applying my knowledge.					
Scientific Reasoning and Critical Thinking	The game encourages me to think critically about how to act during a disaster.					
	The game allows me to interact and make decisions like in real disaster scenarios.					
Motivation	The game is fun and easy to understand.					

and Engagement	I feel more motivated to learn about disaster mitigation through this game.					
Visual and Text Quality	The game design is attractive and makes me want to play.					
	The visuals and colors help me focus and understand the content better.					
	The text in the game is easy to read and understand.					
	The instructions and explanations in the game are clear.					
Comments:						

3.5 Data Analysis Techniques

The data analysis in this study was conducted using several techniques appropriate for the different types of data collected. The overall process involved validating the research product through expert judgment, followed by analyzing student response data.

3.5.1 Product Validity Analysis (Expert Judgment)

To answer the second research question regarding the validity of the simulation game, a quantitative validation process was conducted involving a panel of experts (e.g., subject matter experts and media experts). A questionnaire was developed and used as the primary instrument to gather the experts' evaluation of the product.

The quantitative data from the experts' ratings were analyzed using the Aiken's V formula to determine the validity of each item in the simulation game. The formula is presented in Figure 3.2.

$$V = \sum S/[n(c-1)]$$

Figure 3. 2: Aiken's V Formula

Where:

- V = The Aiken's V coefficient of content validity
- s = The score given by each rater minus the lowest possible score
- r = The rating given by an expert for an item
- lo = The lowest score in the rating scale (e.g., 1)
- n = The number of expert raters
- c = The number of categories in the rating scale (e.g., 5)

After calculating the V coefficient for each item, the score was interpreted using the criteria from (Azwar, 2012), as shown in Table 3.3.

Table 3. 3 Aiken Criteria

Score Average Interval	Criteria
$0.80 < V \leq 1.00$	Very High
$0.60 < V \leq 0.80$	High
$0.40 < V \leq 0.60$	Enough
$0.20 < V \leq 0.40$	Low
$0.0 < V \leq 0.40$	Very Low

Source: (Azwar, 2012)

Based on the criteria in Table 3.3, an item in the simulation game was considered valid and accepted for the final product if it achieved a "High" or "Very High" rating, corresponding to a V coefficient greater than 0.60. Items failing to meet this threshold were subject to revision based on qualitative feedback or were removed. In addition to these quantitative ratings, qualitative feedback from the experts was also analyzed descriptively to guide these media revisions.

3.5.2 Student Response Analysis

To answer the third research question concerning student responses, data were collected using a questionnaire and semi-structured interviews. The student questionnaire was developed based on established theoretical frameworks and indicators relevant to educational simulation games.

a) Quantitative Data Analysis:

Data from the Likert-scale items in the student questionnaire were analyzed using descriptive statistics in SPSS. This included calculating the mean and standard deviation for each item to summarize overall student perceptions.

b) Qualitative Data Analysis:

The qualitative data from both open-ended comments and interview transcripts were analyzed using Thematic Analysis. This process involved the following systematic steps:

1) Familiarization: Repeatedly reading the transcripts and comments to gain a deep understanding of the data.
2) Initial Coding: Labeling segments of text with codes that captured their essential meaning (e.g., "game freeze," "fun animation").
3) Theme Identification: Grouping related codes into potential overarching themes (e.g., "Technical Issues," "Positive Engagement").
4) Reviewing and Defining Themes: Refining and clearly defining the final themes that accurately represented the dataset, which are then presented in Chapter 4.

3.6 Research Procedure

This study was conducted following a systematic three-stage procedure to ensure the development and implementation of the simulation game were rigorous and well-structured.

3.6.1 Preparation stage

The preparation stage involved several steps to lay the foundation for the research. First, the research problems were identified, followed by defining the objectives and specifying the target audience. Next, the appropriate media for the study was determined, and a thorough literature review on simulation games and disaster mitigation was conducted. Research instruments were then constructed and revised based on expert input. Finally, the flowcharts and storyboard of the simulation game were designed, leading to the development of the game itself.

3.6.2 Implementation stage

During the implementation stage, the simulation game was first validated through expert judgments. Feedback was collected from both lecturers and science teachers to ensure the content and functionality of the game were appropriate. Based on these evaluations, necessary revisions were made to improve the game. Subsequently, student responses were collected following the implementation of the game in the classroom setting.

3.6.3 Completion stage

In the completion stage, all data collected from validations and student responses were analyzed to evaluate the effectiveness and quality of the simulation game. The research findings were then discussed in the context of the study's objectives, and finally, the results were compiled into the final research report.

In order to achieve the research objectives, a procedural model was designed to guide the study. The research steps are visualized in the flowchart presented in Figure 3.3 below.

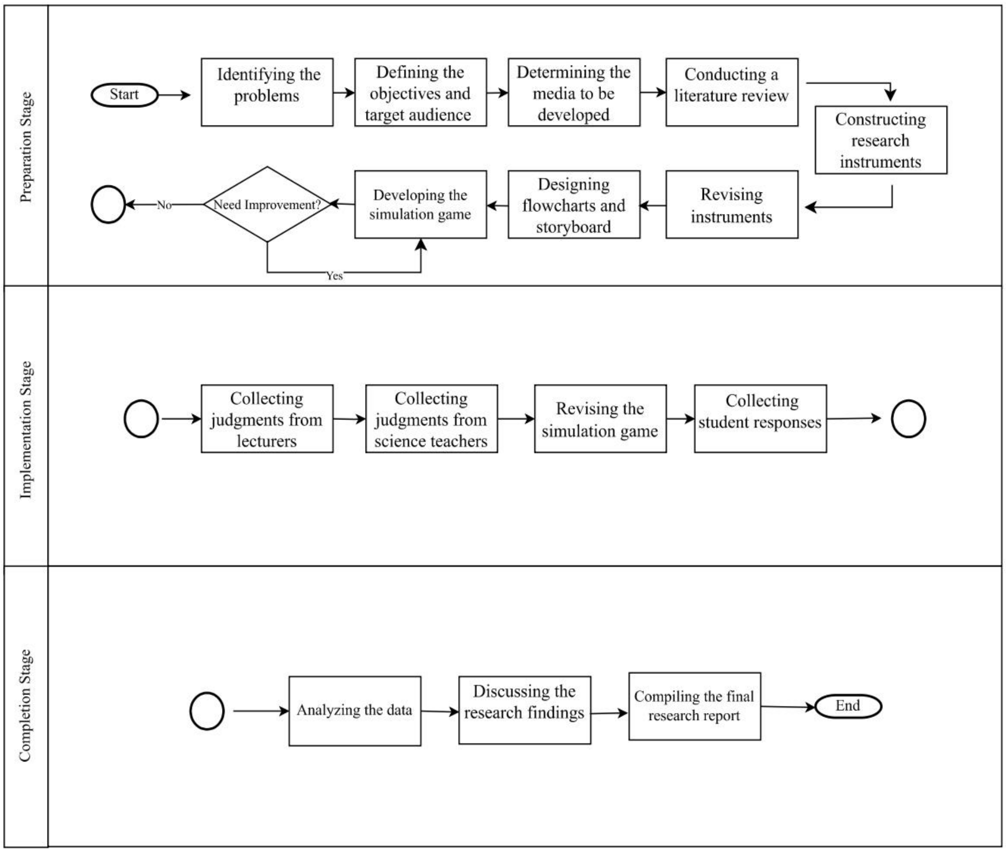

Figure 3. 3: Flowchart of Research Design

As depicted in the flowchart on Figure 3.3, the research was systematically structured into three primary phases: preparation, implementation, and evaluation. The preparation stage encompassed all initial activities, beginning with identifying the core problems through needs analysis and literature review, and concluding with the development of the simulation game prototype. Following this, the implementation stage focused on data collection. This phase involved collecting judgments from a panel of experts for content validation, as well as collecting student responses during product trials to assess the game's practical application. Finally, the evaluation stage involved analyzing the data gathered from both experts and students. The findings from this analysis were then synthesized to draw conclusions, culminating in the compiling of the final research paper.