CHAPTER THREE
RESEARCH METHODOLOGY

This chapter focuses on the discussion of the research techniques that the researcher used to systematically address the particular issues that needed to be looked into. This chapter provided an explanation of the methodology and its research design, respondents of the study, research instrument, research procedures, and statistical analysis of the data techniques being utilized to ensure reliable data analysis and interpretation.

3.1. Research Design

In this study, *Design-Based Research* and a one-group pre-implementation and post-implementation design of quasi-experimental are employed. The Design-based Research (DBR) methodology was adapted for this project, which consists of four phases as mentioned on the study conducted by (Amiel & Reeves, 2008; Wahyudin et al., 2022). The first phase involves studying real-world issues, followed by the creation of solutions based on current design principles and technological advancements. The next phase entails iterative cycles of testing and improving these solutions in real-world settings. Lastly, reflection is conducted to generate design principles and enhance solution implementation. In this particular instance, the researcher is only able to engage in two phases: studying real-world issues and conducting iterative cycles of testing and improving solutions in a real-world setting. As mentioned by Amiel & Reeves (2008), Design-based research's overarching objective is to strengthen the link between academic studies and practical issues. An emphasis is focused on an iterative research process that generates design concepts that can direct comparable research and development activities in addition to methodically attempting to perfect an innovative product or solution. As for the instructional design aspect of this study, the combination of ADDIE model and Rapid Prototyping Design Cycle model proposed by (Shakeel et al., 2023) will be utilized.

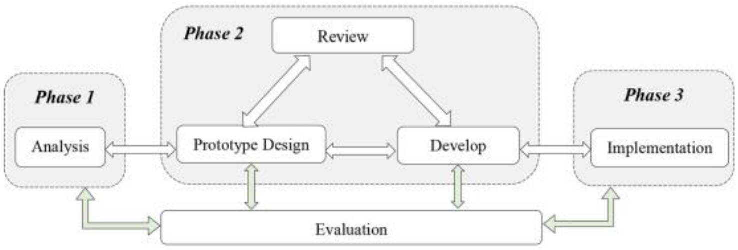

Figure 5. Rapid Prototyping Design Cycle and ADDIE Model

Phase 1: *Analysis stage* which involves designer to engage with the analysis process to determine the **course objectives, contents, instructional strategy, and learners' background** to formulate the conceptual structure of the instructional strategy.

Phase two: *Design and Development* of the Instructional strategies in which the instructional prototype and its development takes place. In designing the prototype, three key design components are considered, i.e., *the learning activities*, *assessment procedures*, and *instructional design*. This is the time when all of the class activities, quizzes, homework, lectures, discussion boards, etc. need to be prepared.

Phase three involves the actual *implementation* of the output where the plan is converted to action. At this stage, the designer makes students ready by letting them utilize the developed output on their own, and deploying the learning environment. In this phase, the course designer must incorporate training sessions to use all the tools integrated into the prototype and conduct an evaluation to measure whether the output is effective or not.

3.2. Research Subject

The target respondents of this study were identified through convenient sampling based on the availability and willingness of the respondents. According to Golzar & Noor (2022), Convenience sampling is essentially using a sample that is easily accessible to the researcher and is available for use in A research. The researcher was unable to choose from a wide range of people and study locations due to financial constraint, respondents' location and availability.

In this study, the enrolled 39 out of 45 Grade 12 STEM (Science, Technology, Engineering and Mathematics) students of Philippine Engineering and Agro-Industrial College Incorporated - Senior High Department were chosen. These number of respondents are the students who were available during the pre-implementation survey and willing to participate for the intervention and post-implementation survey. The Philippine Engineering and Agro-Industrial College, Inc. (PEACI) is an educational institution that operates under the laws of the Republic of the Philippines and is privately owned. It was founded in 2007 by a group of engineers from Mindanao and is properly registered with the Security and Exchange Commission.

Further, this institution has basic and Higher Education programs. Under Basic Education, it is divided into three subdivisions: Elementary, Junior, and Senior High School department. Within the Senior-High Department, it has four (4) academic tracks, these include: STEM (Science, Technology, Engineering, and Mathematics) track, ABM (Accountancy, Business, and Management) track, HUMSS (Humanities and Social Sciences) track, and TVL (Technical-Vocational-Livelihood) track. The identified number of students are currently enrolled under the STEM (Science, Technology, Engineering, and Mathematics) track under K-12 Program of the Department of Education. In this track, all enrolled students are required to take the core subject, such as the Disaster Readiness and Risk Reduction Subject Course which was imposed in response to the Philippine government DRRM advocacy under RA 10121 or the Disaster Risk Reduction Management Act of 2010. The Organizational structure of the research site can be seen in **figure 6**.

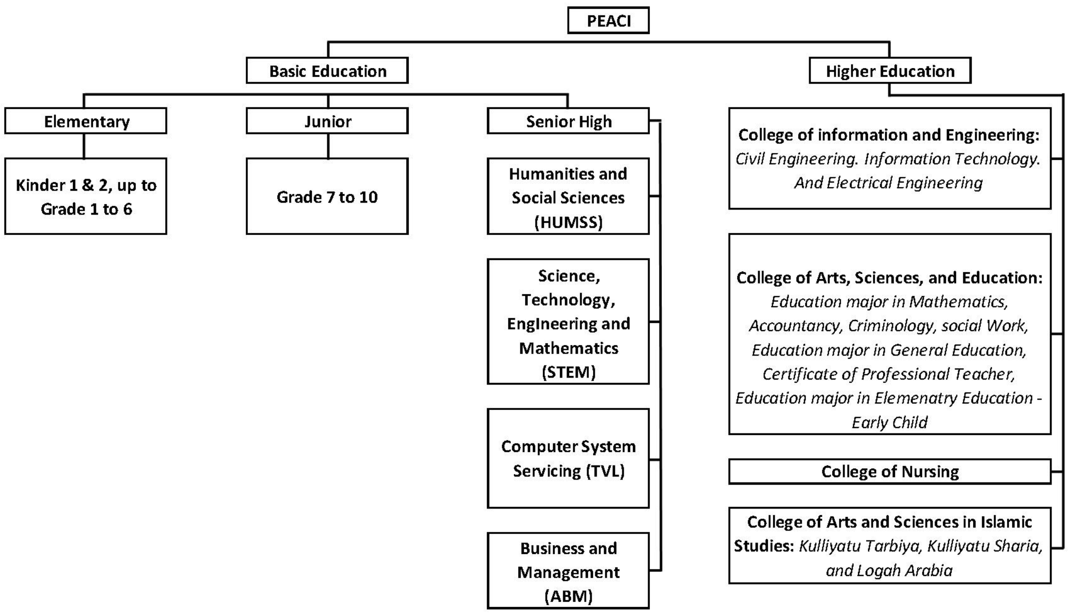

Figure 6. Organizational Structure of Philippine Engineering and Agro-Industrial College, Inc.

3.3. Research Procedure

This study's research methodology, which is appropriate for the design-based research strategy, is a methodical approach directed by the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model and

Rapid Prototype Design cycle model. The three primary stages of the research process for this study are Analysis, Design, Development & Review, and Implementation & Evaluation. Using a combination of document analysis and surveying, the Analysis Phase starts with a determination of key elements such as learning competencies, content, instructional strategies, and learners' backgrounds. The development of the module is based on these data. Key competences, standards for performance, and specific learning objectives are set throughout the design phase. References are gathered, and a low-fidelity prototype in a form of a storyboard to arrange the content structure of the e-module are needed. Using *Figma* software, the prototype is digitized during the development phase. Research tools are also created, such as validation sheets and surveys on student reactions and disaster awareness. Expert opinion is then applied to the first draft in order to assess it and enhance it. The inputs coming from the experts are analyzed using Content Validity Index (CVI) to determine the suitability of the E-module and alignment of the ESD components in the learning activities.

Subsequently, the created e-module is presented to the intended student body as part of the Implementation and Evaluation Phase, and a post-implementation survey is carried out to obtain input. The impact of the e-module is evaluated by analyzing the data gathered using statistical tools, and the findings are presented and justified in discussion section. The study ends with conclusions and suggestions for additional enhancements and uses of the ESD-based e-module. By ensuring that the e-module is thoroughly designed and evaluated, this exhaustive method helps STEM students in the Philippines become more aware of disasters.

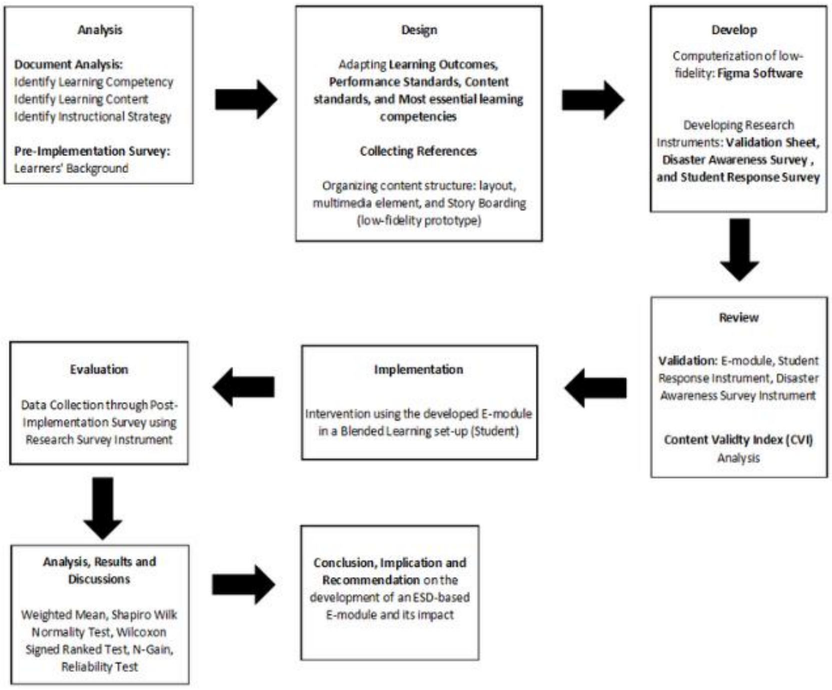

Figure 7. Research Procedure

3.4. Variable Operationalization

Table 3. Variable Operationalization

VARIABLE	OPERATIONAL DEFINITION	Scale
ESD-Based E-module on Disaster readiness and Risk Reduction		
Dual Coding		
Verbal	This refers to the aspects such as clarity and appropriateness of communication or features and expression in a form of a sound, which allows for the sharing of knowledge and interaction.	**Ordinal**
Pictorial	as the visual representation and communication of information and concepts related to disaster awareness and sustainable development.	
Self-Directed Learning:		
Self-Monitoring	as the process in which students actively observe, assess, and regulate their own learning and understanding of disaster awareness and sustainable development concepts.	**Ordinal**
Self-Management	as the ability of the student to independently organize, regulate, and control their behaviors, emotions, and learning strategies within the framework of the ESD focused on disaster awareness.	
Technology Acceptance Model		

Perceived Usefulness	as the practical value and relevance perceived by the students regarding the ESD-based E-module focused on disaster awareness.	**Ordinal**
Perceived Ease of Use	as the degree to which students perceive the ESD-based E-module on disaster awareness as straightforward, intuitive, and user-friendly in terms of navigation, interaction, and accessibility.	
Perceived Intention	as the students' expressed willingness, commitment, and readiness to engage with and actively participate in activities, learning modules, and assessments.	
Students' Level of Disaster Awareness		
Knowledge	this refers to the assessment on the degree of students' recognition on disaster issues.	**Ordinal**
Attitude	refers as students' predispositions, beliefs, perceptions, and emotional responses towards disaster awareness, preparedness, and sustainable development as influenced by their engagement	
Behavior	refers to observable actions, decisions, and practices demonstrated by the students regarding disaster awareness and sustainable development, influenced by their engagement.	

3.5. Research Instrument

The study utilized data collected in real-world field conditions. The research involved the use of non-test tools such as validation sheet and disaster awareness survey questionnaires. Data collection technique and research instrument used can be seen in the **table below.**

Table 4. Research Instrument

No.	Data	Data Collection Technique	Research Instrument
1.	Electronic Learning Material Validation Instrument	***Non-Test***	Validation Sheet
2.	ESD-Based E-module Student Response	***Non-Test***	Survey Questionnaire
3.	Disaster Awareness Survey Questionnaire *(Pre-Implementation and Post Implementation)*	***Non-Test***	Survey Questionnaire

3.5.1. Electronic Learning Material Validation Instrument

Table 5 depicts that the learning material been adopted by the researcher is examined through validation sheet based on the over-all design (content, instructional, and technical quality) to determine whether the learning material is aligned with the ESD component, and the underlying competencies stipulated in the curriculum guide of Enhanced Basic Education (K–12 program) as presented in the material on the theme, Disaster Readiness and Risk Reduction. Validators fill out the validation sheet given and provide their opinions and scores. Following that, the outcome is analyzed using average computations and categorized according to the given parameters.

Table 5. Validation Sheet for Non-print Material Survey Grid

No.	Indicator	Item
Content Quality		
1.	Content Alignment and Integrity	No. 1, 3, 4, 5, 6, and 9
2.	Educational Value and Impact	No. 2, 7, 8, and 10
Instructional Quality		
3.	Instructional Design Quality	No. 1, 2, 3, 4, and 5
4.	Learner Engagement and Adaptability	6, 7, 8, 9, and 10
Technical Qualities		
5.	Multimedia Quality	1, 2, 3, 4, 5, 6, 7, and 8
6.	Usability and Accessibility	9, 10, 11, 12, and 13
	Total	**33**

Table 6. Education for Sustainable Development Component Survey Grid

No.	ESD Component	ESD Indicator	Item
1.	Envisioning	Make plans to enhance quality of life while keeping sustainability in mind for the future.	1
2.	Critical Thinking and Reflection	Examine how environmental	2

		issues and human activity are related.	
3.	Participation in Decision Making	Determine efforts to preserve the quality of the environment.	3
4.	Partnerships	integrating various ideas that come from discussions to address an environmental issue.	4
5.	Systemic Thinking	Create solutions to address sustainability issues by taking social, economic, and environmental factors into account.	5

3.5.2. Student Response Instrument

The purpose of this tool is to assess students' reactions to the ESD theme-based E-module. This tool is a four-response Likert scale questionnaire. **Table 7** shows how the student response instrument grid is arranged.

Table 7. Student Response Survey Grid

No.	Sub-Components	Item
1.	Material	1, 2, 3, 4, 5, 6, 7, and 8
2.	Display	9, 10,11,12,13, 14, 15, and 16
3.	Motivation to Learn	17, 18, 19, and 20
Total		**20**

3.5.3. Student Disaster Awareness Instrument

The researcher employed survey questionnaire that consists of several close-ended questions that must be answered by the respondents. These questions are constructed based on the content of the learning material being developed by the researcher. A 4-point response scale is used by the researcher of this study to gather responses from the subjects. This 4-point Likert scale are as follows: Strongly Agree (**4**), Agree (**3**), Disagree (**2**), Strongly Disagree (**1**). In a Likert scale, participant was asked to rate their level of agreement. Agree or disagree with a range of statements regarding an attitude, an event or an opinion (Chang, 1994; Taherdoost, 2019).

Table 8. Disaster Awareness Instrument Survey Grid

No.	Category (Disaster Awareness)	Indicator	Item
1.	Knowledge	Awareness and understanding of disaster concepts	1, 2, 3, and 4
2.	Attitude	Attitude and beliefs towards disaster preparedness and risk reduction	5, 6, 7, and 8
3.	Behavior	Attitude and behaviors towards disaster preparedness and knowledge sharing	9, 10, 11, and 12

3.6. Data Analysis Technique

The gathered data from the experts with respect to the validity of the research instruments of this study is uttered in a form of a percentage. While the collected data from the student-respondents of this manuscript measuring their level of awareness will be analyzed and calculated using Mean formula, Shapiro Wilk Normality Test, Wilcoxon Signed Rank Test, N-gain, and Reliability Test. Further information in-line with data analysis of this study are as follows:

3.6.1. E-module Validity Analysis

An assessment will be done to the developed e-module using validation sheet to determine the validity of the e-module in terms of its full content quality, instructional quality, and technical quality as well as the ESD components' applicability for media aspects. The following formula was utilized to examine the data regarding the validity of educational material being developed.

$$\text{Valdation} = \frac{Score\ Obtained}{Max\ Score}\ \boldsymbol{x}\ \mathbf{100}\% \qquad (1)$$

Table 9. Classification on the Validity level of E-Module (Aulia et al., 2021)

Percentage Level	Criteria	Classification
81 – 100%	Very Valid	No Need for Revision
61 – 80%	Valid	No Need for Revision
41 – 60%	Quite Valid	Revision
21 – 40%	Less Valid	Revision
0 – 20%	Not Valid	Revision

The validity level of the E-module can be determined through these stipulated criteria: If the e-module material satisfy the requirements, it can be regarded as legitimate or valid and doesn't require further revisions. Qualification standards for validity ranges from 61% to 100%. Revisions to the materials being developed are required if the assessment results fall below the 61% mark.

3.6.2. Student Response Instrument Validity Analysis

The purpose of the analysis of student replies was to ascertain how students felt about learning with ESD theme-based e-modules. Four responses displaying different levels were followed by a Likert scale that was set up in the form of a statement. Strongly Disagree (SD) = 1, Disagree (D) = 2, Agree (A) = 3 Strongly Agree (SA) = 4 were the results. The following formula is being used to examine the data obtained from students' questionnaire response on ESD theme-based e-modules:

Equation:

$$\textbf{Score Percentage} = \frac{\textit{Total of Indicators per Category}}{\textit{Total Category}}\ x\ 100 \qquad (2)$$

The classification of the result of the student response can be seen below adopted from Nurgiyantoro (2001) (Solin & Saragih, 2020). A percentage is produced using the answers to the preceding formula's calculation. Following a conversion of the score classification to a classification in the form of a percentage, the classification is then explained using a qualitative statement seen in table below.

Table 10. Classification on the Student Response on Electronic Module (Solin & Saragih, 2020)

Percentage Level	Classification
81% <X<100%	Very Good
61%<X<80%	Good
41%<X<60%	Moderate
21%<X<40%	Not Good
0%<X<20%	Very Poor

3.6.3. Disaster Awareness Survey Instrument Content Validity Analysis

Expert evaluation served as the means of validating the Disaster Awareness survey questionnaire. The purpose of validation is to assess the degree of agreement between the indicators and the usefulness of the developed questionnaire. Empirical validation was also then carried out using *Content Validity Index (CVI)* (Polit & Beck, 2006). In content Validity Index (CVI), the value of calculated mean item content validity index should be greater than > 0.9

and the *Scale Content Validity Index (S-CVI)/over universal agreement should be greater than >0.9.* If the calculated value is above 0.9, this means that the scale is relevant and or clear. Otherwise, if it is less than <0.9, it means it is not relevant and or clear and it requires revision. The result of the evaluation score from the expert judgement can be seen below.

Table 11. Content Validation Index Result on Knowledge in Terms of Relevance

Variable:	Knowledge					
Assessment aspect:	Relevance					
Item	**Expert 1**	**Expert 2**	**Expert 3**	**3&4 for all expert**	**No. Of agreement**	**Item cvi**
KN1	4	4	4	YES	3	1.0
KN2	4	4	4	YES	3	1.0
KN3	4	4	4	YES	3	1.0
KN4	4	4	4	YES	3	1.0
KN5	4	4	4	YES	3	1.0
Proportion Clarity (PR)	5/5 = 1.00	5/5 = 1.00	5/5 = 1.00	S-CVI/UA = 5/5 = 1.00		Mean I-CVI = 1.00

Table 12. Content Validation Index Result on Attitude in Terms of Relevance

Variable	Attitude					
Assessment Aspect	Relevance					
Item	**Expert 1**	**Expert 2**	**Expert 3**	**3&4 for all expert**	**No. Of agreement**	**Item cvi**
AT1	4	4	4	YES	3	1.0
AT2	4	4	4	YES	3	1.0
AT3	4	4	4	YES	3	1.0
AT4	4	4	4	YES	3	1.0
AT5	4	4	4	YES	3	1.0
Proportion Clarity (PR)	5/5 = 1.00	5/5 = 1.00	5/5 = 1.00	S-CVI/UA = 5/5 = 1.00		Mean I-CVI = 1.00

Table 13. Content Validation Index Result on Behavior in Terms of Relevance

Variable	Behavior					
Assessment Aspect	Relevance					
Item	**Expert 1**	**Expert 2**	**Expert 3**	**3&4 for all expert**	**No. Of agreement**	**Item cvi**
BE1	4	4	4	YES	3	1.0
BE2	4	4	4	YES	3	1.0
BE3	4	4	4	YES	3	1.0
BE4	4	4	4	YES	3	1.0
BE5	4	4	4	YES	3	1.0
BE6	4	4	4	YES	3	1.0
Proportion Clarity (PR)	6/6 = 1.00	6/6 = 1.00	6/6 = 1.00	S-CVI/UA = 6/6 = 1.00		Mean I-CVI = 1.00

Table 14. Content Validation Index Result on Knowledge in Terms of Clarity

Variable	Knowledge					
Assessment Aspect	Clarity					
Item	**Expert 1**	**Expert 2**	**Expert 3**	**3&4 for all expert**	**No. Of agreement**	**Item cvi**
KN1	4	4	4	YES	3	1.0
KN2	4	4	4	YES	3	1.0
KN3	4	4	4	YES	3	1.0
KN4	4	4	4	YES	3	1.0
KN5	4	4	4	YES	3	1.0
Proportion Clarity (PR)	5/5 = 1.00	5/5 = 1.00	5/5 = 1.00	S-CVI/UA = 5/5 = 1.00		Mean I-CVI = 1.00

Table 15. Content Validation Index Result on Attitude in Terms of Clarity

Variable	Attitude					
Assessment Aspect	Clarity					
Item	**Expert 1**	**Expert 2**	**Expert 3**	**3&4 for all expert**	**No. Of agreement**	**Item cvi**
AT1	4	4	4	YES	3	1.0
AT2	4	4	4	YES	3	1.0
AT3	4	4	4	YES	3	1.0

AT4	4	4	4	YES	3	1.0
AT5	4	4	4	YES	3	1.0
Proportion Clarity (PR)	5/5 = 1.00	5/5 = 1.00	5/5 = 1.00	S-CVI/UA = 5/5 = 1.00		Mean I-CVI = 1.00

Table 16. Content Validation Index Result on Behavior in Terms of Clarity

Variable	Behavior					
Assessment Aspect	Clarity					
Item	**Expert 1**	**Expert 2**	**Expert 3**	**3&4 for all expert**	**No. Of agreement**	**Item cvi**
BE1	4	4	4	YES	3	1.0
BE2	4	4	4	YES	3	1.0
BE3	4	4	4	YES	3	1.0
BE4	4	4	4	YES	3	1.0
BE5	4	4	4	YES	3	1.0
BE6	4	4	4	YES	3	1.0
Proportion Clarity (PR)	6/6 = 1.00	6/6 = 1.00	6/6 = 1.00	S-CVI/UA = 6/6 = 1.00		Mean I-CVI = 1.00

Based on the calculated mean item of the *Content Validation Index* gathered from the experts on the research survey instrument measuring the level of disaster awareness of the research subjects. A total mean of 1.0 and a total of 1.0 of the universal acceptance towards content validity index was obtained. These means that the research survey instrument that being used by the researcher are relevant and clear.

3.6.4. Statistical Treatment

The awareness of students for disasters is analyzed using a 4-point Likert scale. The scale was presented as closed statements, followed by 4 possible responses indicating different levels of agreement. The responses and their corresponding scores were as follows: strongly agree (SA) = 4, agree (A) = 3, disagree (D) = 2, and strongly disagree (SD) = 1. Using a 4-point scale is beneficial for young respondents, as it is easy to comprehend and requires less effort to answer. Additionally, it helps to minimize responses that display uncertainty (Chang, 1994; Preston & Colman, 2000; Willits & Theodori, 2016).

Analysis of the student disaster awareness survey questionnaire responses before and immediately following the post survey questionnaire after the application-based e-module will be implemented, was done for this study. Specifically, the following:

3.6.4.1. Weighted Means

The mean and standard deviation were used as a treatment to gauge the research subject's level of awareness toward disaster with respect to their knowledge, attitude, and behavior. The result presented will be one of the bases in informing the development of the e-module. The interpretation guide adopted from (Mohamad Ariffin & Norulhuda, 2020)is displayed in **Table 17**.

Table 17. Scale and Qualitative Description (Mohamad Ariffin & Norulhuda, 2020)

Scale	Qualitative Description
1.00 – 1.74	Low
1.75 – 2.49	Moderately Low
2.50 – 3.24	Moderately High
3.25 – 4.00	High

3.6.4.2. Shapiro Wilk Normality Test

In this paper, Shapiro Wilk Normality Test will be employed using SPSS software to determine if the data is normally distributed or not (KORKMAZ & DEMİR, 2023). Accordingly, the data is improperly distributed if the significance value or probability value is less than 0.05. The data has a normal distribution if the probability or significance value is greater than > 0.05. *SW test* statistic is calculated using the equation below.

Equation:
$$SW = \frac{(a'x)^2}{(n-1)S^2} = \frac{\left(\sum_{i=1}^{n} a_i x_i\right)^2}{\sum_{i=1}^{n}(x_i - \bar{x})^2} \quad (3)$$

3.6.4.3. Wilcoxon Signed Ranked Test

In this study, the researcher used the *Wilcoxon Signed Ranked Test* feature of *SPSS software* to compare the pre- and post-implementation survey scores of the same group of students in order to assess the efficacy of an educational intervention. It can be seen to the Hypothesis of the study that: The alternative hypothesis (H_a) proposes a substantial difference between the scores, whereas the null hypothesis (H_0) asserts that there is no significant difference. However, since the data is not normally distributed, Wilcoxon Signed Ranked Test will be employed to put verdict on the result gathered and to determine if there is a significant difference between the result of the pre- and post-implementation survey.

3.6.4.4. N-Gain

N-Gain was utilized in this study to determine the increase that occurs before and after utilizing the application-based e-module. Compare the pre-implementation survey scores of the student respondents with the post-implementation survey scores in order to assess the improvement in the level of awareness among the student respondents. The following formula adapted from Hake can be used to determine the N-gain value.

Equation: $$< g >= \frac{\sum Post\ response - \sum Pre\ response}{Max\ Score - Pre\ response} \qquad (4)$$

Where,

$< g >$ = N-gain

<$\sum Pre\ response$> = Average Pre response Score

<$\sum Post\ response$> = Average Post response Score

<Max Score> = Maximum Score

The obtained normalized gain value denotes a category of enhanced awareness for disasters. The SPSS software is used to process the N-gain data. The N-gain score categorization for these categories is shown below:

Table 18. N-gain Score Categorization (Prihastari & Widyaningrum, 2022)

RANGE	CATEGORY
$(g) > 0.70$	High
$0.30 > (g) \leq 0.30$	Medium
$(g) \leq 0.30$	Low

Table 19. Effectivity Result Based on N-Gain Result (Prihastari & Widyaningrum, 2022)

Percentage Level (%)	CATEGORY
<40	Ineffective
40 - 55	Less Effective
56 - 75	Quite Effective
>76	Effective

3.6.4.5. Reliability Test

The *Alpha Cronbach's Reliability Index*, adopted from Tavakol & Dennis (2011) (Hassan et al., 2022), used in this study in order to gauge and or to help inform the calculation and interpretation of the internal consistency of the marginal (the test for instance). Accordingly, it is deemed dependable if the reliability coefficient is greater than or equal to 0.07.

Table 20. Reliability index interpretation for Cronbach’s Alpha (Hassan et al., 2022)

Cronbach’s Alpha	**Internal Consistency**
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Table 21. Reliability Test Result using Alpha Cronbach

Aspect	**Alpha Cronbach**	**No. of Items**
Knowledge	.755	4
Attitude	.754	4
Behavior	.919	4

According to the result of the Cronbach's Alpha Reliability Test, it is deemed dependable if the reliability coefficient is more than or equal to 0.07. The items used to measure the level of disaster awareness in terms of knowledge (.755), attitude (.754), behavior (.919) was deemed reliable based on the reliability test results.