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FLIPPED CLASSROOM BASED ON NATURE (FCBN) LEARNING MODEL DEVELOPMENT IN ENHANCING FLOOD DISASTER PREPAREDNESS

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ABSTRACT

Parigi Moutong Regency is prone to flash floods. This situation requires students to be prepared for flooding. Geography education plays a crucial role in building disaster preparedness through an understanding of environmental characteristics, such as landscapes, river flow patterns, land use, and flood-prone areas. However, disaster education in schools is not yet contextualized. Therefore, this study aims to develop a Flipped Classroom-Based Nature (FCbN) learning model to improve students' flood preparedness. The novelty of this study is the integration of the Flipped Classroom model, nature-based learning, and video media into a single learning model for disaster education. The model development used the ADDIE model, which includes analysis, design, development, implementation, and evaluation. Data collection was carried out through interviews, observations, questionnaires, and tests. The results showed that the FCbN model obtained a validity score of 96%, categorized as very valid and feasible to be implemented without revision. Teacher and student responses to the model demonstrated a high level of practicality. The FCbN model has proven effective in improving students' flood disaster preparedness. The independent sample t-test results showed a significance value of 0.021 ($p < 0.05$), indicating a significant difference between the experimental and control classes. A total of 33 students in the experimental class were in the highly prepared category, while only 4 students in the control class achieved that category. These findings indicate that the FCbN model is effective in improving flood disaster preparedness through learning that integrates independent learning, discussion, and direct experience in the natural environment.

Keywords: *flipped classroom based nature; flood disaster; learning model; preparedness*

INTRODUCTION

Flooding is a frequently occurring disaster that causes extensive losses (Munz et al., 2023). Floods result in damage to biodiversity and loss of cultural heritage. In 2021, floods were the most prevalent natural disaster, accounting for 223 of 432 disaster events worldwide (Aslantas et al., 2024; Garg et al., 2024).

The causes of flooding include river sedimentation, heavy rainfall, waste disposal into rivers, and construction along riverbanks (Bagas et al., 2023).

Mitigating flood disaster risk holds critical importance (Syarifuddin et al., 2023). Communities must understand flood-vulnerable zones, historical flood patterns, and contributing factors to flood events (Hardi et al., 2025). Reducing the risk of flooding can be achieved through disaster preparedness. Flood preparedness helps communities develop and plan what actions to take when flooding occurs. Preparedness measures enable governments, organizations, families, and individuals to respond quickly and effectively to disaster situations to reduce losses and loss of life (Destia Rahma & Fitriani Yulianti, 2020). Increasing disaster knowledge is a crucial factor in building community awareness, vigilance, and preparedness for flooding and supporting the creation of a disaster-resilient society (Sakdiah & Zuhra, 2022). Disaster preparedness can be achieved through education, training, and planning based on previous disaster experiences (Novianti et al., 2025; Sakdiah & Zuhra, 2022)

Incorporating flood risk education into school curricula represents an effective strategy for fostering disaster preparedness awareness from childhood. Geography offers an ideal platform for this instruction (Listiqowati, 2025; Tanjung et al., 2025).

Geography education fosters sensitivity and concern for the environment, motivates students to maintain ecological balance and promotes conservation efforts that reduce disaster risks. Through geography teaching, students are expected to change their thinking and behavior, develop preparedness, adaptability, and resilience to disasters (Listiqowati et al., 2026; Silviariza et al., 2020)

Parigi Moutong is one of the districts in Central Sulawesi that is most vulnerable to flooding. In recent years, flooding has occurred annually in various sub-districts such as Torue, Balinggi, Moutong, West Parigi, and Bolano Lambunu.

Parigi Moutong has a diverse landscape, encompassing alluvial plains, coastal plains, river valleys, hills, and mountains traversed by numerous rivers flowing into Tomini Bay. This topography causes water from upstream areas to flow rapidly toward the lowlands, especially during periods of high rainfall. The alluvial plains, which are extensively used for settlements and agricultural land, are particularly vulnerable to flooding because they serve as runoff accumulation areas and are located close to river mouths. Furthermore, steep mountain slopes accelerate runoff, while the numerous rivers flowing into Tomini Bay increase the concentration of runoff in coastal areas. This combination of factors makes Parigi Moutong prone to flooding, particularly in alluvial plains, riverbanks, and coastal areas.

In July 2022, a flash flood in Torue Sub-district resulted in loss of life, material loss, and damage to educational and public facilities. In March 2023, the Taopa River overflowed, inundating three villages in Moutong Sub-district: Paria, Tompo, and West Gio. In May 2023, floods hit Balinggi and Torue Sub-districts, inundating 14 villages, affecting approximately 3,555 people, damaging dozens of homes, and destroying several schools. In May 2024, floods occurred in Balinggi, West Parigi, and Tolai Sub-districts. In August 2025, floods hit Balinggi Jati Village, Balinggi Sub-district, displacing approximately 100 families. In May 2026, floods inundated Tuladenggi Pantai Village in Moutong District, Gunung Sari Village in Bolano Lambunu District, Balinggi Jati Village in Balinggi District, and Tolai Village in Torue District. This event affected many homes, submerged rice fields, and disrupted transportation routes.

The flooding, which occurs annually in Parigi Moutong Regency, is triggered by high rainfall intensity, heavy rains, overflowing rivers, and breached embankments. This series of flooding events demonstrates that flooding is a recurring threat and is widespread across various areas of Parigi Moutong Regency. Therefore, efforts to improve disaster mitigation and preparedness for the community are needed, starting with students living in flood-prone areas through disaster education in schools.

The problem is that not all schools in disaster-prone areas implement disaster preparedness education or training. For example, at SMAN 1 Torue, students have not received flood preparedness education or training. Geography instruction remains conventional and unengaging, with no integration of flood preparedness content into the curriculum.

Based on interviews with geography teacher Asrti Abram, S.Pd, several critical problems at SMAN 1 Torue were identified: 1) Geography instruction follows a monotonous pattern, relying heavily on lecture-based delivery and textbook resources. These textbooks present notable limitations: a) factual information and conceptual frameworks inadequately support analysis of geosphere phenomena through geographic approaches, b) visual representations are sparse and fail to bridge students' abstract thinking gaps, and c) actual flooding processes remain insufficiently illustrated. 2) The learning process emphasizes rote memorization of textbook content, hindering students' comprehension of geographic approaches and skill development. These deficiencies collectively impede the cultivation of flood preparedness awareness among students.

To address this issue, the Flipped Classroom-Based Nature (FCbN) learning model was developed. This learning model combines the Flipped Classroom model with nature-based learning supported by video media. The integration of video allows students to study the material independently before face-to-face learning (Listiqowati et al., 2022).

The Flipped Classroom model delivers learning material through videos that students study before face-to-face activities, allowing class time to be focused on exercises, discussions, completing assignments, and field practice (Bergmann J., 2012; Listiqowati et al., 2025). This model is effective in increasing student learning autonomy, motivation, academic achievement, self-confidence, and understanding (Baepler et al., 2014; Hao, 2016; Kavanagh, 2021; Mehta, 2020; Zarouk et al., 2019). In addition to offering flexibility and learning innovation (Paristiowati et al., 2017; Ramadhani & Fitri, 2020; Shih & Tsai, 2017; Tsai et al., 2020; Zhu et al., 2020) the Flipped Classroom model fosters independent learning, communication skills, and creativity (Chen et al., 2023).

The nature-based learning model emphasizes students' direct engagement with the environment as a contextual learning resource. Through this approach, students can directly observe the characteristics of flood-prone areas, watershed conditions, land use, and factors influencing disaster risk, enabling them to connect theoretical knowledge with real-world conditions in their surroundings. Nature-based learning has been shown to improve spatial thinking and reasoning skills, observation skills, problem-solving, environmental awareness, and disaster preparedness (Amiliya & Aminah, 2020; Bety Yulia Wulansari, 2017; Wulansari, 2017). Furthermore, nature-based learning encourages exploration, interpretation, and discovery, fostering awareness and personal responsibility for the environment (Johnstone et al., 2022; Kuo et al., 2019) also found that nature-based learning contributes to disaster risk reduction by improving students' ability to recognize disaster-prone areas while simultaneously improving academic achievement.

The combination of Flipped Classroom and nature-based learning, FCbN, provides learning efficiency, independent learning, and hands-on learning in nature, providing contextual learning experiences, specifically understanding potential disasters and flood preparedness in the surrounding environment. Flipped Classroom allows students to independently learn concepts through videos before face-to-face sessions, optimally utilizing classroom time for discussion, problem-solving, and field activities. Nature-based learning provides students with opportunities to observe and analyze real-world phenomena in their surroundings, making the concepts learned more meaningful and understandable. This combination supports improved conceptual understanding and learning achievement, developing spatial thinking skills, observation skills, problem-solving, communication, collaboration, creativity, independent learning, and disaster preparedness. Hands-on learning experiences in the natural environment help students recognize the characteristics of disaster-prone areas, increase environmental awareness, and strengthen disaster preparedness and mitigation capabilities.

Therefore, the objectives of this research are: 1) To develop a Flipped Classroom-Based Nature (FCbN) learning model designed to enhance flood disaster preparedness. 2) To validate the effectiveness of the Flipped Classroom-Based Nature (FCbN) learning model in strengthening flood disaster preparedness.

The novelty of this research is the integration of flipped classroom learning with nature-based learning models, focusing on improving flood disaster preparedness.

Various studies have shown that the flipped classroom model is effective in improving learning outcomes, motivation, engagement, and conceptual understanding (Elkhalladi & Sefrioui, 2024; Hernaiz-Perez et al., 2021). However, these studies focused on cognitive aspects and were conducted in the classroom. The novelty of this research is its focus on improving disaster preparedness, emphasizing the importance of contextual learning experiences that allow students to interact directly with the environment to understand disaster risks in a realistic manner.

Furthermore, previous research generally examined the effectiveness of flipped classroom and nature-based learning separately. This research offers a novelty in the form of implementing the flipped classroom-based nature (FCbN) model, which combines video-based self-directed learning with hands-on learning experiences in natural environments to improve flood disaster preparedness.

MATERIALS AND METHODS

1. Development of the Flipped Classroom-Based Nature (FCbN) Learning Model

The FCbN model development employs the ADDIE framework, which stands for Analysis, Design, Development, Implementation, and Evaluation. This framework was selected due to its systematic structure and adaptability in creating more effective educational products. The ADDIE model diagram can be seen in **Figure 1**.

a. Analysis

This phase encompasses needs analysis and feasibility analysis. The needs analysis draws from interview data and preliminary observations conducted at SMAN 1 Torue, which revealed several key issues:

1) The occurrence of flood disasters causing material damage and loss of life,
2) Insufficient flood disaster preparedness among students,
3) Geography instruction at SMAN 1 Torue has inadequately addressed flood disaster preparedness improvement.

The feasibility analysis, based on initial observation findings and teacher interviews, indicates that both teachers and students have the capacity to implement the FCbN model. The natural environment surrounding the school and students' residences provides suitable conditions for supporting learning activities.

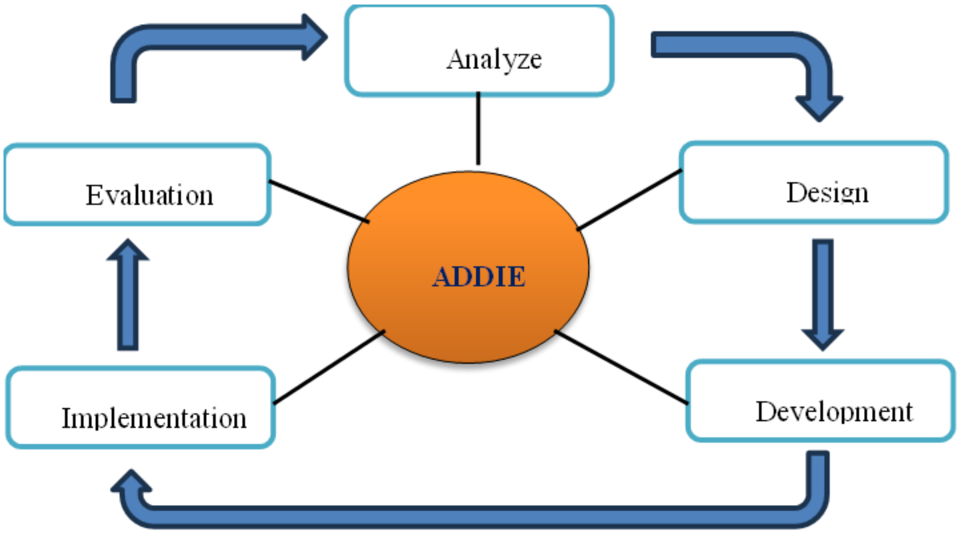

Figure 1. ADDIE Development Model
Source: (Syahid et al., 2024)

b. Design

The design stage of the FCbN model development includes: Syntax design with syntax design including: 1) Introduction (pre-class), 2) Main Activities in the classroom, 3) Learning in nature, 4) Classroom Follow-up, 5) Reporting results. Next is the design of the reaction principle, the design of the social system, the design of the support system, as well as the design of the instructional impact and accompanying impact.

c. Development

The development stage is the FCbN design phase realized into a real product including the preparation of a model syntax consisting of Introduction (Pre-Class), Main Activities in the Classroom, Learning in Nature, Classroom Follow-up, and Reporting Results. In addition, the reaction principle was developed as a guideline for teachers in guiding students, a social system to regulate learning interactions, a support system in the form of learning tools and media, as well as the expected instructional and accompanying impacts. The developed product was then validated by experts to ensure the validity and feasibility of the model before being implemented in learning.

d. Implementation

The implementation phase involved the application of the FCbN model developed in geography teaching by teachers and students at SMAN 1 Torue.

During this implementation phase, a quasi-experimental study was conducted to assess the effectiveness of the FCbN model in improving flood preparedness. This quasi-experiment involved two classes: one as an experimental class implementing the FCbN model, and the other as a control class, using a focus group discussion method. The implementation results included observational data from the FCbN model implementation related to student and teacher activities, student response data, teacher feedback on FCbN, and pre- and post-test results on flood disaster preparedness.

e. Evaluation

The final stage evaluates both product quality and the success of the development process. Quality assessment focuses on product validity, while success is measured through product effectiveness. Evaluation occurs in two phases: first, formative evaluation is conducted throughout each ADDIE stage, identifying and correcting developmental weaknesses and errors in real-time. Second, summative evaluation takes place after full product development to determine the product's effectiveness and utility in achieving geography learning objectives—specifically, enhancing flood disaster preparedness.

2. Population and Sample

The population in this study consisted of all 10 grade XI students at SMAN 1 Torue. The sample consisted of two classes: Class XI P2B and Class XI P2C, each comprising 33 students aged 16-17 years. The two classes were selected based on several considerations, including similar cognitive abilities of students in the two classes, similar number of students in the two classes, and similar geography teachers. The experimental and control classes were determined by drawing lots, with Class XI P2B as the experimental class and Class XI P2C as the control class.

The selection of SMAN 1 Torue as the research location was based on a needs analysis, specifically as a high school located in a flood-prone area, and a feasibility analysis, specifically, the school's facilities and infrastructure, as well as its surrounding natural environment, supporting the implementation of the FCbN model.

3. Data Collection, Research Instruments, and Data Analysis

Data collection techniques used various methods, including:

a. Questionnaire

The questionnaire is divided into 3, the questionnaire for validity testing, the questionnaire for teacher responses and the questionnaire for student responses. The validity testing questionnaire was completed by a validator expert in the field of instructional design. The teacher and student response questionnaires were completed by teachers and students to determine teacher and student responses to the FCbN model. The resulting scores are used as a guideline for drawing conclusions regarding the model developed using the percentage formula shown in equation 1.

$$\text{Percentage} = \frac{\sum questionnaire\ answer\ scores}{n\ x\ \ highest\ score\ x\ \sum students} \tag{1}$$

n : number of questions answered

The conclusion drawn is confirmed by the interval for determining the categories of the developed model as seen in **Table 1** Model Category Interval below:

Table 1. Model Category Interval

No	Achievement Level	Description	Information
1	80,1% -100%	Very good	Highly feasible; no revision needed
2	70,1%-80%	Good	Feasible; no revision needed
3	60,1%-70%	Satisfactory	Moderately feasible; minor revisions needed
4	50,1%-60%	Inadequate	Less feasible; significant revisions needed
5	1%-50%	Poor	Not feasible; major revisions required

Source: (Listiqowati et al., 2022)

b. Test

This test includes a pretest and posttest to determine changes or improvements in disaster preparedness. The test instrument is based on disaster preparedness indicators, as shown in the disaster preparedness table presented in **Table 2** below:

Table 2. Disaster Preparedness Index Parameters

Preparedness Parameters	Weight
Knowledge and Attitude	45
Emergency Planning	35
Warninng system	15
Resource Mobilization Capacity	5
Total	**100**

Source: LIPI-UNESCO, 2006 (Mas'Ula et al., 2019).

After calculating the index for each parameter, sum the values to produce an aggregate score. Then, classify the overall disaster preparedness level by comparing this total against the disaster preparedness index categories shown in **Table 3** below:

Table 3. Disaster Preparedness Level

Index	Category
80%-100%	Highly prepared
65%-79%	Prepared
55%-65%	Nearly prepared
40%-54%	Insufficiently prepared
<40%	Unprepared

Source: (Yatnikasari et al., 2021)

The disaster preparedness instrument was created based on disaster preparedness parameter indicators. Before using this disaster preparedness test instrument, it was piloted at a different school, namely SMA N 1 Palu.

The results of the pilot test were then calculated for validity and reliability. Of the 20 questions tested, all 20 were found to be valid and reliable. The results of the instrument pilot test can be seen in **Table 4**.

The effectiveness analysis began with prerequisite tests for normality and homogeneity using the Kolmogorov-Smirnov and Levene tests, respectively, followed by an independent sample t-test at a significance level of 0.05.

c. Observation

Observation was used to observe the implementation of the program in the classroom during trials in the experimental and control classes.

Table 4. Test Instrument for Flood Disaster Preparedness

No	Developed Competencies	Weight	*Test*	No Question	Status
1	Knowledge & attitude	45	Recognize characteristics of flood-safe zones	1, 2, 3	valid
			Analyze impacts experienced by flood victims	4, 5, 6	valid
			Understand the flood disaster preparedness cycle	7, 8, 9	valid
2	Emergency planning	35	Create flood preparedness plans	10	valid
				11	valid
				12	valid
				13	valid
				14	valid
				15	valid
				16	valid
3	Warningsistem	15	Engage in flood disaster simulations	17	valid
			Apply effective mitigation strategies	18	valid
				19	valid
4	resource mobilization capacity)	5	Flood Preparedness Training Benefits	20	valid

Source : Author's Documentation

RESULTS AND DISCUSSION

1. Analysis

a. Need Analysis

The needs analysis for the FCbN learning model examined learning process requirements, 21st-century learning paradigms, and existing research. Through teacher and student interviews alongside initial school observations at SMA N 1 Torue, several critical weaknesses in geography instruction emerged: 1) instruction relied heavily on theoretical lectures without learning media, resulting in non-contextual learning, underdeveloped spatial thinking, and insufficient student preparedness for flood disasters; 2) teaching prioritized content mastery over applied skill development, despite spatial thinking and disaster preparedness requiring hands-on practice and simulation; 3) minimal technology integration existed; and 4) disaster preparedness was not incorporated into geography instruction.

A literature review on 21st-century learning paradigms revealed that contemporary education must integrate digital technology with environmental and disaster awareness, necessitating learning models that combine digital tools with environmental resources as instructional media. The FCbN model addresses these needs by incorporating digital technology and direct environmental learning, facilitating independent theoretical study, active classroom participation, and contextual environmental connections. Additionally, FCbN employs problem-based learning that fosters collaboration and communication.

An analysis of previous research, conducted through a literature review, suggests that combining nature-based learning with the Flipped Classroom approach can enhance flood disaster preparedness. Research demonstrates that flipped learning develops critical thinking, increases student motivation, and improves learning effectiveness (Andrini et al., 2019; Béres & Kis, 2018; Shih & Tsai, 2017; Strelan et al., 2020). Nature-based learning, which begins with specific problems and emphasizes spatial understanding, can promote disaster preparedness. Studies show that nature-based learning encourages active engagement, the development of problem-solving skills, and spatial understanding (Elkhalladi & Sefrioui, 2024; Endah et al., 2020; Kuo et al., 2019; Murti & Mathez-Stiefel, 2019; Oyao et al., 2015; Yazar & York, 2023).

b. Feasibility Analysis

The feasibility analysis confirmed that the developed Flipped Classroom-Based Nature (FCbN) learning model was suitable for geography instruction aimed at enhancing flood disaster preparedness. Data collection involved teacher and student interviews, as well as initial observations at the school. The analysis evaluated material feasibility, media appropriateness, instructional design, and classroom implementation through user feedback from both teachers and students, with teachers confirming the model's viability. Geography learning materials, using the FCbN model, are aligned with learning outcomes and the geography curriculum's environment and disaster topics. Materials incorporated the local context of flood-prone Parigi Moutong Regency, ensuring relevance to students' lived experiences.

2. Design

The design phase of the FCbN model development includes:

a. Syntax design: designing and compiling the steps of the FCbN learning model according to the integration of flipped classroom with nature-based learning.
b. Reaction principle design: designing how teachers respond, guide, motivate, and provide feedback to students during the learning process.

c. Social System Design: designing patterns of interaction and collaboration between teachers and students, as well as between students, during learning activities.
d. Support System Design: designing and determining facilities, learning video media, learning resources, worksheets, and the natural environment that support the implementation of the FCbN model.
e. Instructional and accompanying impact design: determining expected learning outcomes. The instructional impact is in the form of achieving learning objectives, namely disaster preparedness.

3. Development

The FCbN model developed is a learning model to improve disaster preparedness. The resulting learning model consists of the following components: syntax, reaction principles, social systems, support systems, instructional impacts, and accompanying impacts. The FCbN model syntax is derived from a combination of flipped classroom and nature-based learning to improve disaster preparedness. The FCbN model syntax can be seen in **Table 5**:

Table 5. Syntax of the FCbN Learning Model

No	Syntax	Activity
1	Introduction (pre-class)	Students engage in independent learning at home prior to in-person school sessions using teacher-prepared media and learning materials
2	Main Activities in the classroom	Teacher verifies student comprehension, followed by group formation. Students engage in discussions to identify and formulate spatial problems within their local environment
3	Learning in nature	Students observe spatial phenomena in the surrounding environment, then establish connections with flood disaster vulnerability and conduct flood preparedness simulations
4	Classroom Follow-up	Students gather and organize spatial data, perform spatial analysis, participate in group discussions, and develop concise observation reports
5	Reporting results	Student presentations

Source: (Bergmann & Sams, 2012; Johnstone et al., 2022)

The FCbN model exhibits several distinctive features. First, it prioritizes independent pre-class learning, requiring teachers to develop media or self-study materials for students. This approach enables students to learn autonomously and participate actively during classroom sessions. Second, the model integrates nature-based learning, utilizing the natural environment as a direct educational resource that bridges theoretical concepts with real-world applications. Students observe and investigate natural phenomena firsthand to gain a deeper understanding of geographical principles. Third, nature-

based learning is inherently collaborative and interactive. Students engage in discussions, work in teams, and share observational findings. Fourth, the model adopts a project-based, problem-solving orientation through activities such as creating maps or diagrams, designing disaster mitigation strategies, or conducting environmental analyses to stimulate spatial reasoning and creativity. Fifth, it incorporates technology and geospatial tools, including instructional videos, GIS, and GPS systems. Ultimately, the model aims to develop enhance flood disaster preparedness. RetryClaude can make mistakes. Please double check responses.
The reaction principle guides teachers in their interactions with students, encompassing appreciation, assessment, and responsiveness throughout the learning process (Amiliya & Aminah, 2020; Bruce Joyce, 2003; Joyce et al., 2004; Koh et al., 2010; Prawesti et al., 2025). The FCbN model's reaction principles include the following: 1) facilitating independent learning, where teachers function as facilitators by providing guidance and learning resources. At the same time, students engage in autonomous pre-class learning. 2) discussion-based interaction and collaboration, where classroom interactions center on active discussions. Teachers facilitate student discussions, probe students' comprehension of material, and encourage them to share observational findings and reflections. 3) providing constructive feedback, where teachers offer direct feedback during class discussions or project work. Feedback serves to correct misconceptions and deepen understanding. 4) real context-based learning, where teachers establish connections between theoretical concepts and authentic field experiences. 5) strengthening collaboration and problem-solving, where teachers promote group work, idea sharing, and collective problem-solving activities, such as designing disaster mitigation strategies and mapping risk areas. 6) flexibility and adaptation, where teachers demonstrate flexibility in responding to diverse student needs.

The social system represents the pattern of relationships and communication between teachers and students throughout the learning process. The FCbN model's social system encompasses several key elements: First, the teacher-student relationship positions the teacher as a facilitator rather than the primary source of information, shifting away from teacher-centered instruction. Second, collaborative learning is central to FCbN, emphasizing student cooperation and collaboration. Collaboration in project completion enables peer learning and deepens material comprehension through discussion. Third, the environment as an integral component of the learning system involves students conducting direct field observations to examine geographical concepts and disaster risks. This nature-based learning connects students with authentic contexts, thereby enriching the learning experience. Fourth, technology as a connector utilizes learning videos and digital modules to support independent pre-class learning. Flexible and open communication patterns characterize Fifth, multi-directional teaching interaction.

The FCbN model's support system requires several essential components. First, technology infrastructure, necessitating internet access and digital devices. This infrastructure can be facilitated through online learning platforms such as LMS, Google Classroom, Moodle, Zoom, and similar tools. Second, materials and learning resources, requiring teachers to provide instructional materials in various formats including books, modules, digital content, videos, PowerPoint presentations, and other media. Third, access to the surrounding natural environment as a direct and contextual learning resource, encompassing rivers, parks, forests, beaches, mountains, disaster-prone areas, and similar locations. Fourth, school support, including permission for outdoor activities and provision of transportation. Regarding instructional and nurturant effects, the instructional effect encompasses the enhancement of flood disaster preparedness. The nurturant effects include: 1) increased independence and responsibility in learning, 2) enhanced technology utilization, 3) strengthened collaboration and social skills, and 4) heightened environmental awareness and connection with nature.

The developed FCbN model was then validated by a Learning Design expert. The validation assessment of the FCbN learning model yielded a score of 96%, placing the model in the very high validity category. Therefore, the developed FCbN learning model is valid and can be implemented without revision. The validator noted that the developed model has the appropriate syntax for disaster preparedness training, making it highly suitable for improving disaster preparedness.

4. Implementation

The implementation was conducted to test the effectiveness of the FCbN model in improving disaster preparedness through a small group quasi-experimental trial.

The quasi-experiment was conducted in two classes: Grade XI P2B as the experimental class and Grade XI P2C as the control class. The experimental class implemented the FCbN model, while the control class used the usual learning approach, namely the discussion method. Both groups were given pretests and posttests to assess changes in disaster preparedness. After implementation, teachers and students were given questionnaires to assess their responses to the developed FCbN model.

The results of the questionnaires, along with the pretest and posttest results, are as follows:

a. Teacher's Response to the FCbN Model in Geography Instruction for Enhancing Flood Disaster Preparedness.

Teacher questionnaire responses revealed that the theoretical framework underlying the FCbN model aligns well with both the Merdeka curriculum currently implemented at the school. The model's components including syntax, social system, reaction principles, and support system demonstrate clarity, logical progression, systematic organization, and a student centered approach. The instructional steps appropriately address disaster preparedness needs, while clearly defining the teacher's role as motivator and facilitator. Overall, teacher feedback on the FCbN model was positive, indicating its viability for classroom implementation.

b. Students' Response to The FCbN Model In Geography Learning to Enhance Students' Flood Disaster Preparedness.

Based on the results of the questionnaire given to students, it was found that in general, the Nature-Based Flipped Classroom (FCbN) learning model received a positive response from students, as can be seen in the following **Table 6**:

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Table 6. Response Student Against the FCbN Model

FCbN Model Syntax	Activity Student	Answer Student
Pre -Class	Study independent before face advance via video media	Most of the student answer like do Study independent before face face and able understand material in a way independent through media
In Class	Discussion and preparation learning in nature	As big student answer can validate his understanding through discussion and can prepare learning in nature
Learn ing in Nature	Observation phenomenon nature and associated with vulnerability disaster flood	Most of the student answer easy understand area vulnerable disasters and increase preparedness disaster through learning in nature
Action continue in class	Collect and organize spatial data, and create observation report	Most of the student answer can increase collaboration and improvement understanding preparedness disaster
Reporting Results	Presentation	Most of the student answer can increase skills communication , literacy information preparedness disaster , and believe self

Source : Author's Documentation

Most students responded positively to the implementation of the FCbN model. They enjoyed independent learning before face-to-face sessions and were able to understand the material through learning media. Discussions helped validate understanding and prepare for learning activities in nature. Nature-based learning facilitated student identification of disaster-prone areas and enhanced disaster preparedness. Furthermore, this model improved collaboration, disaster awareness, communication skills, information literacy, and student self-confidence.

c. Implementation of the FCbN Model in Geography Learning to Enhance Students' Flood Disaster Preparedness.

Classroom observations during FCbN model implementation revealed highly effective execution. From the syntax aspect of the learning model, observation data demonstrated that the FCbN activity sequences were clear, logical, and comprehensible. The learning phases progressed systematically from pre-class activities (video viewing or e-learning), through classroom activities (discussion and problem-solving), to field activities (nature-based learning), following a coherent

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structure aligned with learning objectives. These findings indicate that teachers implemented the FCbN learning syntax both consistently and systematically.

From the social system aspect, classroom observations revealed dynamic, communicative, and collaborative interactions between teachers and students. Teachers served as facilitators and motivators, while students demonstrated enthusiasm and took responsibility for their own learning. The pre-class video activities prepared students effectively for in-person sessions. Students engaged actively in group discussions, problem-solving exercises, and outdoor learning experiences, successfully identifying and resolving spatial challenges.

From the aspects of reaction principles and learning management, teachers demonstrated strong classroom management capabilities. They verified video completion before face-to-face sessions, guided reflective practices, and supervised discussion activities and fieldwork. Students exhibited independent, collaborative, and creative learning behaviors aligned with FCbN model principles. Observation data confirmed high-level implementation of the FCbN model in classroom settings. The approach successfully fostered an active, meaningful, and contextually relevant learning environment by integrating digital resources with hands-on nature experiences. FCbN implementation enhanced not only student motivation and participation but also cultivated spatial reasoning, problem-solving competencies, and disaster readiness within Geography learning.

d. Pretest and Posttest Results

Disaster preparedness assessment results for the experimental and control classes are presented in the following **Table 7**.

Table 7 shows differences in disaster preparedness classifications between the experimental and control classes. In the experimental class, the highest classification is "highly prepared," comprising 33 students, while in the control class, the highest classification is "highly prepared," comprising only 4 students.

Table 7. Disaster Preparedness Assessment Results in Geography

No	Score	Classification	Experimental Class		Control Class	
			Pretest	Post test	Pretest	Posttest
1	81-100	Highy prepared	0	33	0	4
2	66 - 80	Prepared	20	0	8	17
3	56 - 65	Nearly prepared	3	0	5	11
4	41- 55	Insufficiently prepared	7	0	6	1
5	0 - 40	unprepared	3	0	14	0
Total			33	33	33	33

Source : Author's Documentation

Table 8 Normality Test

	class	Kolmogorov-Smirnov			Shapiro Wilk	
		Statistic	df	significance.	Statistik	df
Disaster Preparedness	Control pretest	.162	33	.028	.924	33
	Control post test	.212	33	.001	.904	33
	Experimental pretest	.267	33	.000	.865	33
	Experimental posttest	.513	33	.000	.393	33

Source : Author's Documentation

Table 8 demonstrates that pretest and posttest results for both experimental and control groups exhibited normal distribution, with Shapiro-Wilk significance values exceeding 0.05.

Table 9. Homogeneity Test Results for Disaster Preparedness Pretest and Posttest

		Levene Statistic	df1	df2	sig.
Flood Disaster Preparedness	means	1.306	1	64	.257
	Median	1.153	1	64	.287
	Based on Median and with adjusted df	1.153	1	62.541	.287
	Based on the trimmed mean	1.270	1	64	.264

Source : Author's Documentation

Table 9 displays a mean-based significance value of 0.255 > 0.05, indicating that the posttest variances in the control and experimental groups are homogeneous. Subsequently, an independent samples test was conducted.

Table 10. Statistical Group

	Kelas	N	Mean	Standard Deviation	Std. Error Mean
Disaster preparedness	Post test of Control Class	33	7.12	1.053	.183
	Post test of Experimental Class	33	9.85	.442	.077

Source : Author's Documentation

Based on **Table 10**, the experimental group's mean posttest score of 9.85 exceeded that of the control group, which was 7.12, representing a substantial difference between the two groups. This suggests that the FCbN model yielded greater improvements in disaster preparedness compared to the discussion method. To further examine this difference, an Independent Sample T-test was conducted, with results presented in **Table 11**:

Table 11. Independent Samples T-Test Results

		Levene's Test for Homogeneity of Variances		T-test for homogeneity means	
		F	Significance	T	df
Disaster Preparedness	The Assumption of equal variance	**19.878**	.000	-13.715	64
	The Assumption of unequal variance			-13.715	42.913

Source : Author's Documentation

The independent samples t-test yielded a significance value of 0.021 ($p < 0.05$), indicating a significant difference in mean scores between the experimental and control groups. Flood disaster preparedness development differed significantly between the two classes.

The FCbN Model demonstrated a significant effect on both flood disaster preparedness. Post-test results showed that For flood disaster preparedness, the experimental class scored a mean of 9.85, while the control group scored 7.12.

Implementation observations of the FCbN model across its syntactic stages showed several key outcomes. During the pre-class phase, students demonstrated heightened motivation, greater learning autonomy, and improved preparation, with these activities strengthening student independence and engagement (Ramirez et al., 2016). During the in-class phase, students consolidated their understanding through extended discussion time (Hoshang et al., 2021) and case-based problem-solving. The flipped classroom structure allowed for more class time for hands-on practice and in-depth analysis of cases. The outdoor learning phase involved students collaborating in groups to observe spatial phenomena, examine spatial relationships tied to disaster risks, and engage in flood disaster preparedness simulations. This phase fostered both individual and cooperative learning while strengthening spatial awareness, problem formulation capabilities, and analytical reasoning in problem-solving. These findings demonstrate that the FCbN model effectively develops flood disaster preparedness competencies, aligning with established theoretical frameworks in both areas.

Observations in the experimental class revealed that students initially developed foundational knowledge through face-to-face instruction, which prepared them for case studies, problem-solving, and outdoor activities. During outdoor learning, students conducted direct field exploration, observation, research, and hands-on problem-solving. These experiences fostered environmental appreciation, strengthened their sense of responsibility toward nature, and provided valuable recreational engagement (Kuo et al., 2019; Yazar & York, 2023).

The control class relied solely on the discussion method without video media or active learning strategies. This method had significant drawbacks: discussions consume considerable time, limit information exchange, and allow vocal students to dominate (Wulandari et al., 2022).

Students arrived unprepared, and tight schedules prevented adequate coverage of the material. The result was poor classroom management, weak digital literacy, and a lack of motivation for independent learning. Without outdoor activities, students missed opportunities for exploration, observation, and hands-on fieldwork (Endah et al., 2020). Learning remained abstract and classroom-confined, offering limited practical experience or real-world problem-solving skills. As a result, the control class demonstrated weaker disaster preparedness compared to their experimental counterparts.

5. Evaluation

The evaluation took place in two phases: an ongoing assessment during development and a final assessment after implementation. During development, evaluators refined the model to ensure validity and quality by aligning its structure with learning objectives, student characteristics, and planned activities. After implementation, they measured student disaster preparedness the model's intended outcome using instruments calibrated to specific preparedness indicators.

CONCLUSIONS

This research successfully developed the Flipped Classroom-Based Nature (FCbN) learning model to improve flood disaster preparedness. Based on expert validation, the FCbN model scored 96%, categorized as highly valid, making it suitable for use in learning without requiring revision. The practicality test also demonstrated a very positive response from teachers and students. Teachers considered the FCbN model easy to implement and appropriate for learning needs. Students found it helpful in understanding the material through video-based independent learning, discussions, and nature learning activities.

The FCbN model proved more effective than conventional learning in improving students' flood disaster preparedness. This was demonstrated by the student preparedness classification in the experimental class, which was dominated by 33 students in the "very prepared" category, while in the control class only 4 students fell into the same category. The independent sample t-test also showed a significance value of 0.021 ($p < 0.05$), indicating a significant difference between the experimental and control classes. These findings indicate that the implementation of the FCbN model has a positive impact on improving students' flood disaster preparedness.

The main novelty of this study is the integration of the Flipped Classroom model with nature-based learning designed for disaster education. FCbN combines independent learning before face-to-face learning, classroom discussion and reflection, and hands-on learning experiences in real environments. This integration enables students to connect disaster concepts with their surrounding environmental conditions, making learning more contextual and meaningful, and significantly improving disaster preparedness.

This research has important implications for the development of geography education and disaster mitigation education. The FCbN model can be an innovative learning alternative that integrates knowledge, skills, and attitudes into disaster learning. Therefore, the FCbN model can be implemented in schools located in disaster-prone areas as part of efforts to build a culture of disaster awareness and resilience. This study also has the disadvantage that the model was implemented in only one school with a limited sample size, so the results cannot be widely generalized. Furthermore, the study focused solely on flood disaster preparedness and was conducted over a relatively short period of time, making it unable to describe the long-term impact of the FCbN model on changes in students' preparedness behavior. Therefore, future researchers are advised to test the FCbN model on a larger sample size and across different regional characteristics and educational levels.

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