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Ventusky's Influence on Hydrometeorological Disaster Preparedness, Considering Learning Styles and Gender

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ABSTRACT

This study aims to analyze the effect of using Ventusky as a learning medium on hydrometeorological disaster preparedness and to explore the role of gender and learning styles as moderating variables in the effectiveness of this media. It was conducted at SMA Negeri 2 Kota Langsa City (Public High School) with 67 students as respondents. The research used a quantitative method with linear regression analysis of moderation to test the impact of Ventusky learning media on hydrometeorological disaster preparedness and the influence of gender and learning styles as moderating variables. The results show that learning styles help increase the effectiveness of Ventusky as a learning medium to improve hydrometeorological disaster preparedness, while gender does not have a significant effect. This conclusion is based on the adjusted R^2 value = 0,851 with an F test p-value = 0,000. Based on the analysis, this study recommends further research on students' learning styles related to hydrometeorological disaster preparedness. Additionally, the match between the use of learning media and students' learning styles should be considered by teachers to support efforts in achieving targeted learning outcomes.

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1. INTRODUCTION

Hydrometeorological disaster preparedness is an essential skill for students as members of the community to handle extreme weather events such as floods, landslides, and droughts (BPBA, 2023; UNDRR, 2019; United Nations, 2019). In Indonesia, improving hydrometeorological disaster preparedness among students is particularly crucial because the country is situated in a tropical rain zone that is vulnerable to these hazards (Abdillah et al., 2023). This skill is not just extra knowledge but a basic necessity to ensure students' safety as part of the community. Classroom disaster education plays a vital role in supporting this goal (Logayah et al., 2023; Marlyono & Triyanto, 2023). The learning process should be designed to provide both theoretical knowledge of hydrometeorological disasters and practical skills including emergency response behaviors. For example, teachers can include activities like evacuation drills, preparing disaster preparedness bags, or recognizing natural warning signs within the curriculum. Through this structured and relevant education, students can become more aware of risks and better equipped to respond effectively during disasters (Sarah Fatima P & A Cortez, 2022).

Disaster preparedness for students involves more than memorizing various disaster types; it encompasses developing a wide range of skills and understanding. This includes understanding disaster risks, such as identifying geographic and social vulnerabilities in their environment (Santos-Reyes et al., 2024). Additionally, preparedness involves the ability to implement effective mitigation actions, like planning evacuation routes or securing valuables before a disaster happens. It also requires the capacity to respond quickly during a disaster, which depends on making sound decisions under pressure. The essential skill for hydrometeorological disaster preparedness is the ability to understand and interpret complex meteorological and hydrological data (Hoffmann & Muttarak, 2017; Nguyen et al., 2025). Learners need to be able to read weather reports, predict potential flooding based on rainfall, or identify natural warning signs of danger. The training process should help them turn this technical information into practical actions. Building preparedness through disaster education is a long-term investment in creating a more resilient and confident community in the face of natural disasters.

The use of disaster data visualization technology in education has proven to help improve disaster preparedness (Pratama, 2022). Platforms like Ventusky (https://www.ventusky.com/) that display weather and climate data interactively and visually hold great potential for enhancing students' disaster preparedness. Ventusky allows students to develop a more complete understanding, which boosts their disaster preparedness. Through Ventusky, students can interpret atmospheric phenomena and weather patterns, and even forecast the impacts that might cause hydrometeorological disasters. Ventusky can serve as an alternative learning tool that bridges the gap between abstract and concrete information for students. This approach not only makes learning more engaging but also gives students better insight, helping them become more proactive in efforts to reduce the risk of hydrometeorological disasters in their communities (Ashfaq & Nabi, 2022).

Based on these arguments, this study aims to analyze the influence of Ventusky as a learning medium on hydrometeorological disaster preparedness, moderated by gender and learning style. This research emphasizes the importance of creating disaster learning strategies customized to student needs, enabling teachers to deliver differentiated instruction. Incorporating digital tools such as Ventusky in disaster education can significantly improve students' comprehension of complex natural events (Pratama, 2022; Sejati, 2023). Additionally, including moderating variables, specifically gender and learning style, seeks to determine whether Ventusky's effectiveness varies between male and female students. This

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is crucial to ensure that the learning media used is inclusive and benefits all students equally. Then, learning style variables like visual, auditory, and kinesthetic were included to evaluate if individual differences in how students absorb information affect Ventusky's effectiveness, given the platform's predominantly visual design. The findings from this study are expected to offer more comprehensive, current insights for teachers and disaster education practitioners regarding the most effective and adaptable disaster learning strategies that account for diverse student characteristics.

2. LITERATURE REVIEW

2.1. Ventusky and Hydrometeorological Disasters

Ventusky is a web-based application created by InMeteo that offers interactive and real-time weather visualizations. This tool allows users to track meteorological data like rainfall, air pressure, wind direction and speed, temperature, and humidity in both space and time. The data shown is sourced from global numerical weather models, such as the Global Forecast System (GFS), European Centre for Medium-Range Weather Forecasts (ECMWF), and Icosahedral Nonhydrostatic (ICON). Ventusky's use in education is important because it displays atmospheric phenomena visually and accurately, enhancing students' understanding of atmospheric dynamics and the risks of hydrometeorological disasters. Its features support disaster mitigation and preparedness by providing a data-driven approach to learning. A study by (Ashfaq & Nabi, 2022) found that learning media that emphasize visual literacy and real-time data significantly increase student attention and participation in understanding the concept of extreme weather. Ventusky presents data in the form of interactive maps, not only strengthening the visual aspect of learning but also supporting contextual learning based on local case studies. The research of Wiratmaja et al. (2023) in Slawi, Tegal, on the integration of technology and active participation in disaster learning shows that the use of Web-GIS based on participatory mapping can increase community capacity in disaster mitigation. If adapted to the school environment, a similar approach can encourage active student involvement in the learning process and build disaster literacy from an early age.

Integrating spatial visualization tools like Ventusky into the curriculum marks a significant advance in disaster education. By enabling students to interact with real-time atmospheric and hydrological data, this approach does more than improve their understanding of complex phenomena such as severe weather and their potential impacts. It actively prepares them to be vital members of an early warning system in their communities (Marlyono & Triyanto, 2023; Santos-Reyes et al., 2024). Instead of passively receiving information, students are empowered to interpret and share crucial data, effectively becoming agents of change. This hands-on experience turns abstract knowledge into practical skills, allowing them to make informed decisions that could save lives and property. This educational approach helps create an educational ecosystem that is both flexible and responsive to disaster risks. It goes beyond traditional, static lessons by offering a tool that reflects the unpredictable nature of weather events (Sarah Fatima P & A Cortez, 2022). This teaching shift directly supports the principles of smart city development, which focus on community involvement and resilience. In a smart city framework, citizens are not just recipients of technology; they actively contribute to creating a safer environment. By training students to be skilled in using tools like Ventusky, schools are nurturing a new generation capable of using technology to build a more resilient society (Ashfaq & Nabi, 2022). This integrated learning model, therefore, not only addresses the immediate need for disaster preparedness but also encourages a culture of technological literacy and civic responsibility essential for sustainable urban growth.

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2.2. Gender and Disaster Preparedness

Disaster preparedness depends not only on an individual's knowledge but also on psychosocial and pedagogical factors, including gender and learning style (Bunyamin & Isa, 2022; Telaumbanua & Harefa, 2024). Gender significantly affects risk perception and decision-making during disasters. Research by Sarah Fatima P & A Cortez (2022)shows that women are often more attentive to preparedness information because of their social responsibility to protect their families. Conversely, men tend to adopt a physical, hands-on approach to disaster threats (Arvind, 2020). Besides gender, learning style also plays a key role in how people absorb and process disaster information. Coffield (2024) categorizes learning styles into three main groups: visual, auditory, and kinesthetic. Each requires a different instructional approach for maximum effectiveness. Buckley & Doyle (2017) found that visual-based media, such as simulations or digital maps, are more effective in enhancing comprehension and retention for visual and kinesthetic learners.

Ventusky, as an interactive learning tool, can accommodate different learning styles. By presenting weather data through maps, colors, and animated movements, it is especially effective for students with visual and kinesthetic learning preferences. At the same time, the accompanying narrative or discussion can support students who learn auditorily. However, research specifically examining how gender interacts with learning styles in disaster preparedness remains very limited. In disaster studies, understanding how gender affects disaster preparedness is essential (Alston, 2014). Gender is not just a biological characteristic but a social construct that shapes roles, responsibilities, and access to resources (Huluka, 2022). These differences greatly influence how individuals and communities respond to disaster threats. For instance, women often serve as caregivers at home, which can limit their mobility during evacuations. Additionally, access to early warning information and involvement in community decision-making are frequently unequal between men and women. Therefore, studying how gender differences impact knowledge, attitudes, and preparedness behaviors is very important. A thorough understanding of this relationship is vital for creating inclusive and effective disaster education. Bunyamin & Isa (2022) highlight the importance of culturally and gender-responsive teaching in building an equitable and effective learning environment in STEM and disaster contexts.

3. METHOD

This study aims to examine the effect of Ventusky learning media on hydrometeorological disaster preparedness in Aceh's eastern coastal region, considering learning styles and gender as moderating variables. The outcome of this study is a multiple linear regression equation that can explain effective learning strategies using Ventusky learning media to enhance learning outcomes and disaster preparedness significantly. Mathematically, this study will generate the following multiple linear equations.

$$Y = \beta_0 + \beta_1 X + \beta_2 M_1 + \beta_3 M_2 + \beta_4 (XM_1) + \beta_5 (XM_2) + e$$

Where:

Y	= Dependent variable (hydrometeorological disaster preparedness).
X	= Independent variable (use of Ventusky as a learning medium).
M_1	= First moderator variable (gender).
M_2	= Second moderator variable (learning style).

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β_0, β_1, β_2, β_3, β_4, and β_5 = Coefficient values.
XM_1 & XM_2 = Interaction between independent and moderator variables.
e = Residual, i.e., other factors outside the model.

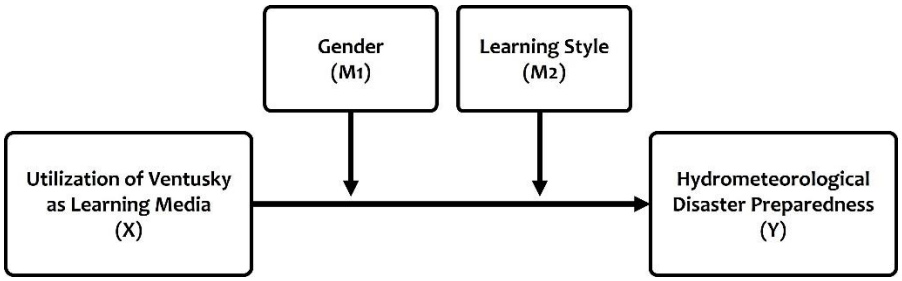

Figure 1. Model variables that describe Ventusky's impact on disaster learning, with gender and learning style as moderating variables.
Source: Research Data (2025)

This study involved four variables: the independent variable being the use of Ventusky learning media, the dependent variable being hydrometeorological disaster preparedness, and moderating variables comprising gender and learning styles. Data collection was carried out in a quasi-experimental manner at SMA Negeri 2 Langsa City, using test instruments and questionnaires. Disaster preparedness was measured with a test consisting of 15 multiple-choice questions. Learning styles were assessed using a questionnaire with a five-point Likert scale, including responses such as "strongly agree," "agree," "neutral," "disagree," and "strongly disagree." The experimental group (Class X-A) had 35 respondents, while the control group (Class X-B) had 32, totaling 67 participants. The data analysis employed moderated regression analysis with one dependent variable (Y), hydrometeorological disaster preparedness; one independent variable (X), the use of Ventusky learning media; and two moderating variables (M_1 and M_2), namely gender and learning styles. This analysis not only predicts how Ventusky learning media influences disaster preparedness but also examines how gender roles and learning styles amplify Ventusky's impact on this preparedness.

4. RESULTS AND DISCUSSION

The effectiveness of learning media in enhancing hydrometeorological disaster preparedness varies and cannot be viewed uniformly. Several inherent factors in students can actually boost or diminish the impact of these media. In this study, gender and learning style are believed to significantly influence how Ventusky learning media affects students' level of preparedness for hydrometeorological disasters. Ventusky is an innovative web-based application that, because of its highly visual and interactive features, helps students better understand atmospheric spatial patterns. This platform converts complex meteorological data into engaging and straightforward visual representations. Its various features, such as visualizations of rainfall, temperature, air pressure, and cloud and wind movements, can turn concepts that students previously found abstract into observable and relatable phenomena. Difficult concepts like cyclone formation can be directly demonstrated using Ventusky.

The respondents involved in this study were students at SMA Negeri 2 Kota Langsa, from class X-A (experimental group) and class X-B (control group). Class X-A studied hydrometeorological disaster mitigation material without using Ventusky as a learning tool, while class X-B learned the same material but with Ventusky. The number of respondents was

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34 in class X-A and 32 in class X-B. The gender distribution in both classes was nearly balanced. The respondent composition is shown in Figure 3. Additionally, students' learning styles were categorized into three groups: visual, auditory, and kinesthetic, based on questionnaire responses. The scores for hydrometeorological disaster preparedness varied among students, with the experimental group (X-A) achieving higher average scores than the control group (X-B). More details can be found in Figures 4 and 5.

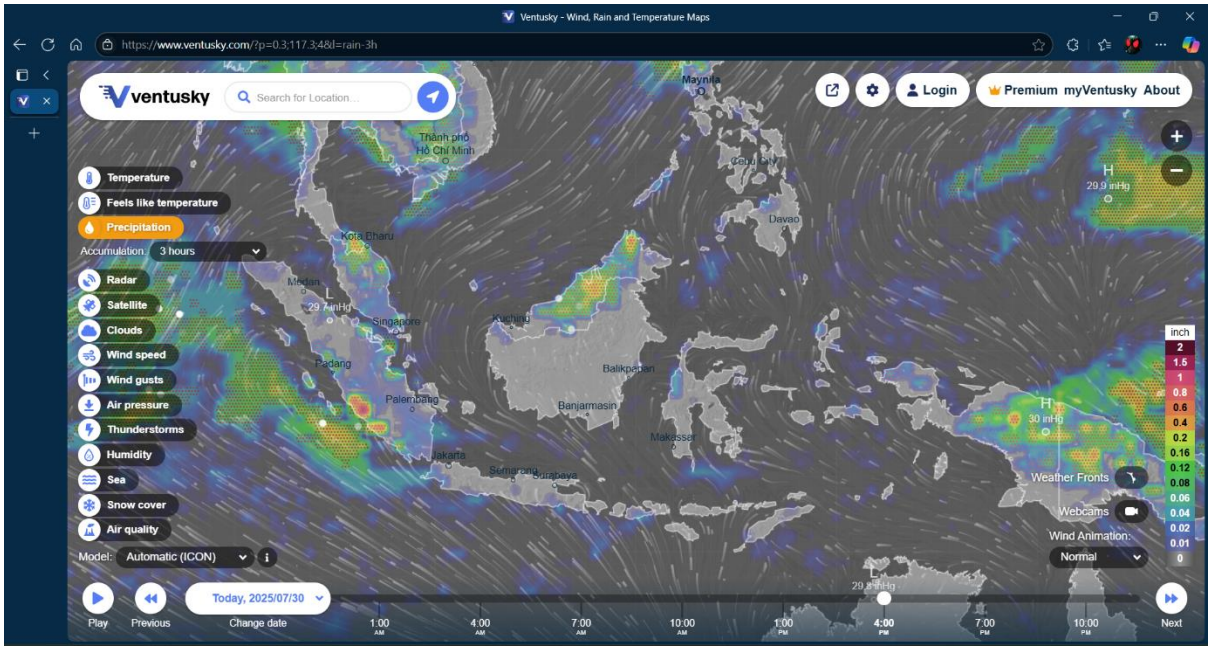

Figure 2. The Ventusky app display can be accessed at https://www.ventusky.com/.

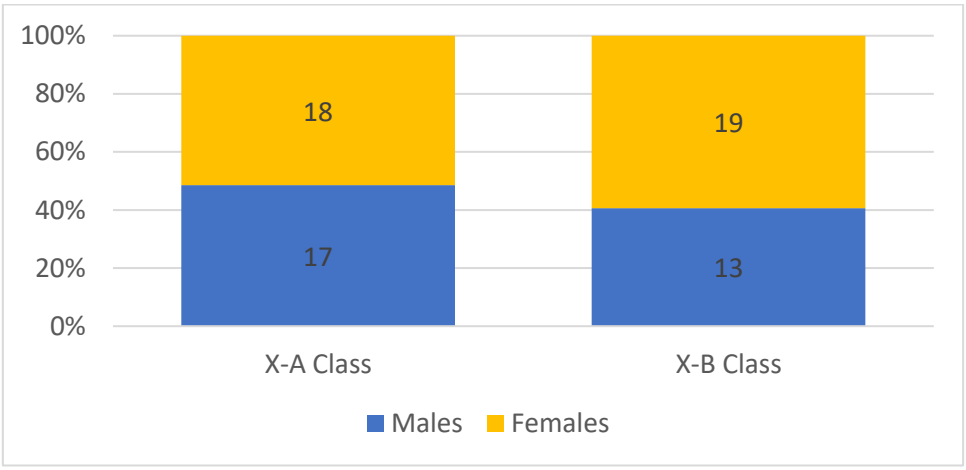

Figure 3. Distribution of respondents by gender for the experimental and control groups. The total number of respondents was 67, including 35 from class X-A (experimental group) and 32 from class X-B (control group).
Source: Research Data (2025)

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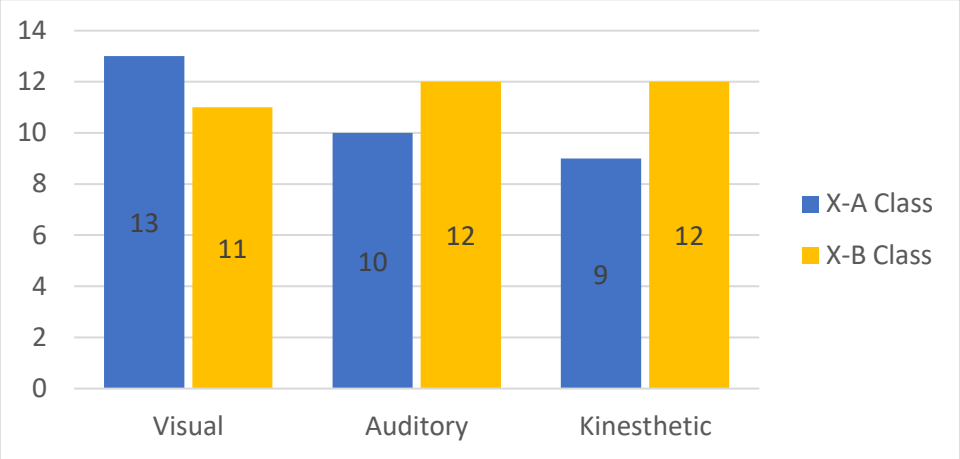

Figure 4. Respondent composition based on learning styles. Each class is divided into three learning styles, i.e., visual, auditory, and kinesthetic.
Source: Research Data (2025)

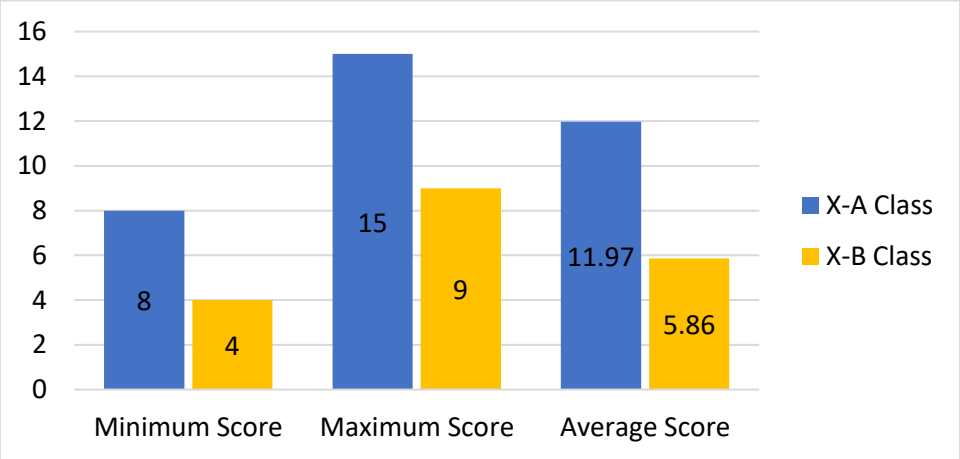

Figure 5. Hydrometeorological disaster preparedness scores for X-A (experimental group) and X-B (control group).
Source: Research Data (2025)

This research uses moderated linear regression analysis to explore how gender and learning styles influence the use of Ventusky as a learning tool for enhancing hydrometeorological disaster preparedness. The data were analyzed using SPSS 22 with moderated linear regression techniques. Gender and learning styles serve as moderating variables that can either facilitate or hinder Ventusky's effectiveness in helping students improve their hydrometeorological disaster preparedness. The findings are presented in Tables 1, 2, and 3.

Table 1. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	0,931[a]	0,867	0,851	1,411	0,102	15,157	3	59	0,000

a. Predictors: (Constant), ventusky, auditory_style, gender, kinesthetic_style, inter_ventusky_kinesthetic, inter_ventusky_auditory, inter_ventusky_gender
Source: Research Data (2025)

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Table 2. ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	766,223	7	109,460	55,001	0,000[b]
	Residual	117,418	59	1,990		
	Total	883,642	66			

a. Dependent Variable: disaster_preparedness
b. Predictors: (Constant), ventusky, auditory_style, gender, kinesthetic_style, inter_ventusky_kinesthetic, inter_ventusky_auditory, inter_ventusky_gender

Source: Research Data (2025)

Table 3. Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	5,599	0,478		11,725	0,000
	gender	-0,318	0,478	-0,044	-0,665	0,508
	auditory_style	0,393	0,589	0,051	0,667	0,507
	kinesthetic_style	0,810	0,589	0,103	1,374	0,175
	ventusky	8,810	0,674	1,212	13,066	0,000
	inter_ventusky_gender	0,416	0,694	0,050	0,599	0,551
	inter_ventusky_auditory	-4,361	0,837	-0,428	-5,211	0,000
	inter_ventusky_kinesthetic	-5,262	0,851	-0,494	-6,186	0,000

a. Dependent Variable: disaster_preparedness

Source: Research Data (2025)

Table 1 shows that this moderated linear regression model is strong and significant. This is indicated by the adjusted R^2 value of 0,851, which means that the independent variable, along with the moderating variable, explains 85,1% of the variance in the dependent variable. Additionally, the p-value < 0,05, which is 0,000, indicates that the model is highly significant. Furthermore, in Table 2, based on the F-test, it can be concluded that this model is very robust and can be used to explain the research problem. The F test results show a value of 55,001 with a p-value of 0,000. This means all variables examined in this study are statistically significant. Meanwhile, Table 3 displays the results of the t-test, which analyzes individual variables to determine their contribution to the overall significance of the model. The table highlights several important figures, particularly in the rows for gender, auditory_style, kinesthetic_style, and ventusky. Each analysis produced p-values (sig.) of 0,508, 0,507, 0,175, and 0,000. The first three numbers are values greater than 0.05, and the last number is a value less than 0.05. This suggests that the gender and learning style variables individually do not influence the improvement of hydrometeorological disaster preparedness. Meanwhile, the Ventusky variable exerts a significant influence on the enhancement of disaster preparedness. For additional information, the Ventusky variable presented in Table 3 implicitly incorporates visual learning styles into the model. Furthermore, the inter_ventusky_gender, inter_ventusky_auditory, and inter_ventusky_kinesthetic rows respectively show p-values of 0,551, 0,000, and 0,000. This value indicates that the interaction of the gender variable with Ventusky does not have a significant effect (p-value > 0,000). This shows that there is no difference between male and female respondents regarding Ventusky's

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use for improving disaster preparedness. Meanwhile, learning styles influence the effectiveness of Ventusky learning media. Furthermore, the values in Table 3, columns 3 in the standardized coefficients, can be combined into a linear equation as follows.

$$Y = 5{,}599 + 8{,}810X - 0{,}318M_1 + 0{,}393M_{2a} + 0{,}810M_{2k} + 0{,}416(XM_1) - 4{,}361(XM_{2a}) - 5{,}262(XM_{2k}) + e$$

Where

Y = Hydrometeorological Disaster Preparedness
X = Use of Ventusky learning media (including visual learning styles)
M_1 = Gender
M_{2a} = Auditory learning style
M_{2k} = Kinesthetic learning style
XM_1 = Interaction variable between gender and Ventusky
XM_{2a} = Interaction variable between auditory learning style and Ventusky
XM_{2k} = Interaction variable between kinesthetic learning style and Ventusky

The results of the moderation regression analysis revealed significant findings that can be used to develop disaster mitigation learning strategies. Gender is a moderating variable that does not influence the effectiveness of Ventusky learning media. This indicates that the efficacy of Ventusky learning media is not affected by students' gender. Both boys and girls have equal opportunities to enhance their preparedness through this media. From an educational perspective, this finding supports the concept of educational equality, where innovative learning designs can bridge potential cognitive or social differences between genders (Habib et al., 2022). In other words, good learning media should not be gender-specific. Ventusky, as a visual-interactive media, successfully meets this standard. Ventusky's impact on improving understanding and preparedness is not limited to one gender but is universal.

Furthermore, the research findings suggest that the learning style exerts a significant influence on the relationship between variable X and variable Y, particularly among students with visual learning preferences. Students with visual learning styles showed the highest significance scores compared to those with auditory and kinesthetic learning styles. Consequently, they also exhibited the highest levels of hydrometeorological disaster preparedness among the three groups. Ventusky is a platform that relies heavily on visual representations, such as interactive maps, cloud movement animations, and dynamic weather charts. This feature makes it easier for students with visual learning styles to absorb the information presented by the platform (Derici & Susanti, 2023). They more quickly connect visual data with abstract concepts like wind patterns or rainfall potential. A teacher using Ventusky can enhance learning by emphasizing visual elements, such as asking students to analyze storm movements on a map or compare air pressure visualizations across regions. Students with visual learning styles tend to be better at constructing their understanding when information is presented in images or diagrams. They not only see but also process and build spatial simulations based on the visual information they receive. In Ventusky's case, they developed an understanding of hydrometeorological disasters by processing the visual data provided.

Overall, these findings offer practical guidance for educators. First, they confirm that Ventusky is gender-neutral, making it an inclusive tool for classroom use. Second, they

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emphasize the need for differentiated learning strategies. Since visual learners benefit most from using Ventusky, teachers can create activities specifically targeting visual learners, while also providing extra support for students with other learning styles. For auditory learners, teachers can supplement Ventusky with group discussions or intensive Q&A sessions about the observed phenomena. Meanwhile, for kinesthetic learners, teachers can design simulations or hands-on projects, such as building a topographic model of a disaster-prone area, to connect the visual information from Ventusky with physical experiences. These findings do not imply that Ventusky is ineffective for auditory or kinesthetic learners, but rather suggest that its full potential can be realized by adjusting teaching methods to accommodate different learning styles.

Hydrometeorological disaster preparedness is an essential skill for students, especially in Indonesia, which has a tropical rainy climate with a high risk of flooding. This emphasizes the importance of disaster education in the classroom, not only to fulfill curriculum requirements but also to develop disaster mitigation skills that are applicable in real-life situations (Takayama et al., 2022). In this context, the appropriateness of learning media to various learning styles needs special attention to help students succeed. Media that are designed without considering students' learning style preferences are often less effective in transferring information, which can ultimately hinder their level of preparedness. For example, media that rely heavily on visualization may work well for students with visual learning styles but be less effective for students with auditory or kinesthetic learning styles. Conversely, media that are tailored to specific learning style needs can enhance cognitive processes, improve understanding, and ultimately enable students to turn knowledge into concrete preparedness actions.

5. CONCLUSION

This study provides robust evidence that learning styles significantly influence how effective Ventusky is as a learning media for improving hydrometeorological disaster preparedness. The results clearly show that a student's learning style, particularly their preferred way of processing information, has a major impact on their ability to absorb knowledge and develop a deep understanding of complex weather and climate topics presented on the platform. This underscores the need to move beyond a one-size-fits-all educational approach. However, the research indicated that gender was not a significant factor in the learning process, implying that Ventusky's impact on disaster preparedness is gender-neutral. This finding is important for promoting educational fairness, as it confirms that the platform’s effectiveness is not limited by biological sex. It indicates that the platform's visual and interactive features are accessible to both male and female students, enabling equal benefits for all users.

The implications of these findings are highly relevant for developing adaptive learning designs in disaster education and learning. Educators can use this knowledge by thoughtfully incorporating students' learning styles, especially visual learning styles, into their teaching strategies. For instance, a teacher utilizing Ventusky could design activities that specifically require students to interpret animated maps and graphical data, thereby resonating effectively with visual learners. This customized method facilitates a more personalized and efficacious learning experience, assisting each student in enhancing their preparedness skills. Additionally, these results highlight the broader idea that effective teaching requires a clear understanding of individual learning characteristics. Aligning learning media with students’ main learning styles has been shown to directly impact the efficiency of the learning process and, ultimately, the achievement of educational goals. Therefore, adapting instructional

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methods to fit student preferences is not just a good practice but an essential part of building a more resilient and well-prepared future generation.

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