VLP Simulation: An Interactive Simple Virtual Model to Encourage Geoscience Skill about Volcano

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Abstract. The purpose of this study was to describe physics students predicting skills after following the geoscience learning using VLP (Volcano Learning Project) simulation. This research was conducted to 24 physics students at one of the state university in East Java-Indonesia. The method used is the descriptive analysis based on students’ answers related to predicting skills about volcanic activity. The results showed that the learning by using VLP simulation was very potential to develop physics students predicting skills. Students were able to explain logically about volcanic activity and they have been able to predict the potential eruption that will occur based on the real data visualization. It can be concluded that the VLP simulation is very suitable for physics student requirements in developing geosciences skill and recommended as an alternative media to educate the society in an understanding of volcanic phenomena.

1. Introduction
Volcanoes phenomenon was an interesting issue in geoscience learning [1, 2], however, the lack of learning interactive media has not been able to facilitate the optimal activity in the classroom. Therefore, it was necessary designing a simulation media that was able to accommodate the students’ requirement in learning about geosciences concept interactively as an effort to encourage geoscience skills [3]. Many volcanic simulation programs have been developed by geoscience educators and researcher at the international level, including Computer Aided Instruction or CAI [3], Interactive Virtual Earth Science Teaching or InVest [4], Vhub [5], MIAVITA [6]. These programs proved able to support the community to understand the phenomenon of the volcano but it must be modified and adapted according to the physics students need in order to improve geoscience knowledge and predicting skills based on volcanic activity in Indonesia.

VLP (Volcano Learning Project) is a simple virtual simulation model that has developed to accommodate futuristic geoscience learning. This software provides an opportunity for students to take advantage of technology facilities [5], interaction with a wider and access more diverse range of authentic information sources based on the real data of volcanic activity in Indonesia which less underutilized as a learning resource. This model becomes a virtual media to provide knowledge about geoscience and can be used to exercise the geosciences skills to equip students to be more capable to solve the problems based on the real of geological data [7], to describe basic geosciences phenomena.
in the various contexts [8], to get better understanding the science behind phenomena [9], and help students to understand volcanic activity that cannot be directly observed [10]. Become a hope, the software capable of supporting the physics student has a high-level order thinking [11].

The fundamental problem to be answered through this research is how the volcano simulation in optimizing geoscience learning. The research focuses are describing characteristics of the volcano simulation software that was developed, improving predicting skill for physics student, and describing student’s perception about VLP in the geoscience learning context. Collecting data from the student learning result and questioner about student perception and conducting analysis through qualitative and quantitative.

2. Experimental Method
This research is an implementation of the development of virtual simulation software about volcano. That was implemented in the Department of Physics in one of the state university in East Java. The design used is quasi experiment with one sample pre-test post-test design. This research was conducted to 24 physics student in the class of 2014 in February 2017 who was taking the course of Earth and Space Sciences in academic years of 2016/2017. The measured ability is the students' predicting skill based on VLP simulation and student perception analysis to software that was developed for getting to know its suitability to the requirement of student in geoscience learning.

3. Result and Discussion
3.1. VLP simulation

Figure 1 shows a design of simple simulation software was developed by researchers. This software were inspired by the “Eruption software! A volcanic crisis simulation” developed by Carl E. Renshaw that was accessed from www.dartmouth.edu. The software is about the volcanic disaster crisis and is designed interactively to develop decision-making skills [3]. As a novelty of the VLP simulation is the eruption parameters equipped with the more of volcanic earthquake types (low frequency, hybrid, deep earthquakes, shallow earthquakes, long distance tectonic and local tectonic) in accordance with the data obtained from PVMBG and coupled with environmental temperatures. These parameters are not founded from the developed previous software. In addition, the software is simpler and very easy to be operated by all user levels. It is very likely to help in educating the community in the understanding of volcano activity.

![Figure 1. Design of VLP interface with Mitigasi Bencana (Disaster Mitigation) feature](image)

The data used by researchers in software development is the real data of volcanic activity. That is accessed from the Centre of Volcanology and Geological Hazard Mitigation or Pusat Volkanologi dan Mitigasi Bencana Geologi (PVMBG). The data used include volcano-seismic data, SO2 flux when the...
volcano is active, volcano deformation, and changes in environmental temperature due to volcanic activity. This context as adapted from the New Zealand’s geoscience emergency and management [12]. Students are tasked to analyse eruption activity based on visualization and various eruption parameter data.

Table 1. The results of student analysis of volcanic activity based on physics parameters

| Activity status | Activity indicators based on physical parameters |
|-----------------|--------------------------------------------------|
| Normal          | Dominated by low frequency earthquakes with an average frequency of 15 Hz, the average flux rate of 120 -160 tons/day, unstable deformation (up and down) and environmental temperature average is 22°C. |
| Watchful        | Dominated by a long distance tectonic with an average frequency of 65 Hz, the number of SO₂ fluxes increases compared to normal status (230-260) tons/day, the deformation is stable and tends to rise and unstable temperatures in the ranges of 20-26°C and tend to rise. |
| Standby         | Dominated by deep earthquakes with frequency> 70 Hz, the number of SO₂ flux is increased up to 350 tons/day and temperature tends to rise 23-28°C. |
| Watch out       | Dominated by shallow earthquakes with frequencies between 70-100 Hz, the number of SO₂ fluxes reaches 420 tons/day, soil deformation tends to rise, and the average environmental temperature reaches 25-30°C. |

Table 1 shows a description of volcanic activity identified by visualization and various eruption parameter data. The results of this analysis were used as a basis for predicting volcanic activity based on the cases and presented in the form of group activities.

3.2. Students description of volcanic activity based on VLP

Figure 2. One example of representation of the volcanic activity based on eruption parameter from the VLP (a) seismic (types and frequency), (b) SO₂ flux released (ton/days), (c) deformation (m), and (d) Environmental temperatures (°C)

Figure 2 shows the volcanic activity based on eruption parameters, such as the seismic, flux, deformation, and environmental temperature. The real data accessed from the recording of volcanic
activity at 29 October to 31 November 2013. All data show up in graphics. Using interpretation in graphical form can help students to make easy to understand numerical data through images [13].

Based on student’s analysis of volcanic activity in VLP simulation, students understanding about eruption parameter is good enough. Students can explain the types and characteristics of volcano earthquakes and find the dominant type of earthquake as a marker of eruption based on their frequency. In addition, the students also managed to identify the amount of SO$_2$ flux released into the atmosphere at the time of volcanoes will be an eruption. The deformation changes and environmental temperature fluctuation are well explained.

**Table 2.** The ability of each group in analysing volcanic activity data based on VLP software

| Groups | Volcanic status  | Logical reasoning                                                                 |
|--------|------------------|-----------------------------------------------------------------------------------|
| I      | Watchful         | Dominated by type A earthquake, SO$_2$ flux decreased but still more than 160 tons/day, deformation experienced inflation, and environmental temperature between 23-26°C. |
| II     | Standby          | The amount of SO$_2$ flux between 250-400 tons/day, the environment temperature between 20-27°C. |
| III    | Watchful         | Dominated by deep earthquakes, the number of SO$_2$ fluxes, deformation increases, and temperature decreases. |
| IV     | Watchful         | Seismicity is dominated by an earthquake in (VB), the amount of SO$_2$ flux, deformation and environment temperature is decreases. |
| V      | Watch out        | Increased SO$_2$ flux (>350 tons), deformation tends to increase, shallow earthquakes (VB) is high. |
| VI     | Standby          | Volcanic activity is dominated by shallow earthquakes, the amount of SO$_2$ flux between 250-400 tons/day and environment temperatures between 20-27°C. |

Based on table 2, students can determine the status of volcanoes and present of them about logical reasoning although the volcano status was determined differently. This skill was strongly influenced by the ability to analyse data and the ability to make conclusions according to the benchmarks made in the previous phase. Based on these results, groups II and group VI can determine the status of volcano correctly, but for other groups is incorrect.

3.3. Assessing students predicting skills and several findings

After following the learning activities using VLP, students perform the final test using predicting skill test was developed by the researcher.

**Table 3.** Description of physics students predicting skill by using paired sample test

| Paired Differences | Mean  | Std. Deviation | Std. Error Mean | 95 % Confidence Interval of the Difference | t     | df  | Sig. (2-tailed) |
|-------------------|-------|----------------|-----------------|------------------------------------------|-------|-----|-----------------|
|                   | Pretest-Posttest | -3.229E1 | 21.39988 | 4.36823 | -41.32804 | -23.25529 | -7.392 | 23 | .000 |

Based on the results of the statistical analysis using paired sample test (table 3), we can be seen that the learning by using VLP simulation significantly influence the predicting skills of physics students. This can be seen from the significance value (2-tailed) of 0.000 <0.050. It can be concluded that learning by using VLP simulation media can improve predicting skill of physics students.

Nevertheless, there are several findings related to the ability of students to develop predicting skills consists of the ability to processing information, presenting in the graphs, the ability to make conclusions based on graphics, and predicting skill based on data.
Table 4. Profile of student ability in developing predicting skills.

| Aspects                                           | Average ability (%) |
|---------------------------------------------------|---------------------|
| Ability to processing information                 | 89.16               |
| The ability to present data in graphical form     | 59.72               |
| Ability to formulate conclusions                  | 66.67               |
| Predicting skill based on data                    | 66.67               |

Table 4 illustrates the students’ ability to develop predicting skills. The gain of student’s geoscience concept through learning with VLP interactive media can help students in predicting volcanic activity. The ability of students in data processing is the best aspect (89.16%) and the presenting data in the graphical form is the lowest ability (59.72%), while the ability to formulate a conclusion and predicting skill based on data is good enough (66.67 %). Based on the data it can be seen that understanding the graphic is easier than making a graphical representation. Drawing a graph as a visual representation requires an understanding of the content, context, and construction [14]. The success of drawing graphs is closely related to the science process skill [15], especially in making the conclusions and prediction.

Figure 3. Student’s perception about VLP software

To ensure that the VLP software is in line with the student’s needs, conducted an analysis of the questionnaire results is distributed to the students. The results of the analysis on student perceptions about VLP software can be seen in figure 3. Most of the physics students stated that the VLP software is a great fit applied in geoscience learning. The software is very helpful in understanding the geoscience concept and volcanic phenomenon, more than 50% of students strongly agree if the software is able to support geosciences skills (predicting skills), and almost 80% of students said the VLP is very appropriate as a media in geoscience learning. Based on these results can be said that the VLP as a computer-based simulation is feasible to be used as a media to improve student’s skills in geoscience learning.

Some suggestions are regarding the refinement of VLP software is the amount of observation data needs to be added so that the more options can be analysed by users. In order to be widely used by the public, it is strongly recommended that the software is applied to the smartphones, making it more accessible in helping people to understand about volcano.

4. Conclusion

VLP interactive simulation is an effective media in developing geoscience skills for physics students. Through this software, students are easier to understanding volcanic phenomena. This conclusion is
supported by the results of the statistical analysis. The VLP simulation was significant to influence the physics students predicting skills. This can be seen from the significance value (2-tailed) of 0.000<0.050. Furthermore, students can explain the types and characteristics of volcano seismic and find the dominant seismic type as a marker of an eruption. In addition, the students also managed to identify the amount of SO$_2$ flux released into the atmosphere at the time of volcanoes will erupt, deformation changes and environmental temperature can well be explained. As a note, the student's skills are still low in making a graphical representation based on data. Students should have a good graphical representation to get the perfect of predicting skill. Based on the results of the analysis of student perceptions can be seen that the VLP software is a suitable simulation for physics students in studying the volcanoes phenomenon and recommended as a media to educate the community about volcanoes.

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