Developing Students’ Critical Thinking Skills Using the Field Laboratory for Geography Education
(Case Study on Mount Galunggung, Tasikmalaya, West Java, Indonesia)

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Abstract: Purpose of the study: This study aimed to analyze the needs of the field laboratory for geography education which functions as an outdoor learning medium.
Methodology: The method applied in this study was descriptive qualitative research using three stages, namely preliminary needs analysis studies, field analysis studies through observation and satellite image overlay, and field function analysis for learning purposes.
Main Findings: The results indicated that the open space (environment) can function as a laboratory that can be used for teaching and learning, research, and community services. In addition, critical thinking skills that can be developed in the field laboratory for geography education included analytical skills, synthetical skills, identifying and problem-solving skills, concluding skills, and evaluating or assessing skills.
Applications of this study: This study provides geography teachers with information to develop a field laboratory as a learning resource.
Novelty: There are very few studies that examine field laboratories, whereas field laboratories are indispensable to develop students’ critical thinking skills.

Keywords: Field Laboratory, Geography Education, Mount Galunggung

1. Introduction

The study of outdoor learning shows a relationship and has a positive effect on meaningful outdoor learners’ experiences. However, several studies also have shown that students spend less time studying outdoors (Doliopoulou & Rizou, 2012; Roberts, 2009; Soga & Gaston, 2016; Todt, 2006). In addition, based on the study (Dyment, 2005; James & Williams, 2017; S. Waite, 2010) there has been a substantial and fundamental decline in outdoor teaching activities in recent years in several Western countries, which has an impact on the lack of student experience. (Pleasants, 2009; Rickinson et al., 2004) have described five main barriers to the learning process outdoors, namely (1) teachers’ fear and concern about the area used for the learning process and also student safety, (2) the level of teacher trust in students and teacher expertise in outdoor learning, (3) school curriculum regulations (for example in the curriculum providing little or limited time for outdoor learning activities), (4) difficulty in managing time, resources, support, and (5) broad systemic change. Furthermore, Dillon & Dickie (2012) added other factors, provide opportunities for teachers to participate in to relevant training to improve teachers’ ability to utilize the environment as a place of teaching and learning. With the consideration of the importance of student experience in doing outdoor learning activities, a study of indicators in utilizing nature for learning is needed, so that students can explore their cognitive abilities by utilizing the environment.

Many earth and environmental sciences make practicum activities in room and field laboratories, field observations, and field studies as the basis for studying them (Ramasundaram et al., 2005). Geography is one of the earth sciences whose learning process is best combined with conducting field observational investigations. Geographical phenomena can be a very fundamental and important topic to be used as material for discussion related to student life (Butzow, 2019; J. Waite et al., 2017). Experience in the field can have a good effect on a person’s thinking ability (Butzow, 2019). According to Garrison & Vaughan, (2008) several things that need to be considered in developing learning activities in the field include the need to choose the best or most feasible approach to be applied, the strategies used and the equipment needed. Consider the study from (Mirrahmi et al., 2011) that Outdoor learning that involves the natural environment can have a good effect on students in various aspects, including: cognitive achievement, social intelligence, and emotional intelligence. Involving students in learning activities in the field directly can stimulate conceptual thinking skills which can then improve deep thinking skills about a theory or problem in scientific studies (Peercey & Troyan, 2017).
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Research needs for the development of geography related to the field require models, methods, detailed approaches and in-depth analysis so that the need to meet an adequate standard field laboratory must be also demanded. Geography teaching and learning in its application require models, media for teaching aids, and modules, and learning resources relevant to the content of the geosphere. The laboratory needed for geography learning is not only a room laboratory, but a field laboratory is also needed to avoid verbal understanding of teaching materials. To improve students’ cognitive, affective and psychomotor abilities, a field laboratory design that meets the minimum standard criteria is required and is relevant to the geographical material content. Utilizing nature as a field laboratory is expected to provide experience to students and provide various life skills in the 21st century, one of which is critical thinking skills.

2. Methods

This research was conducted in three stages and used a descriptive approach, namely; preliminary studies, field analysis studies and analysis of field functions for learning. In the first stage, the researchers conducted a preliminary study in the form of literature research by carrying out a needs analysis by considering the latest research developments and opportunities to conduct a study. In the second stage, the researchers conducted with field survey methods and zoning of the area that can be utilized by validating the data from field observations of the area of Mount Galunggung to serve as a field laboratory. In the third stage, the researchers conducted a field function analysis for conducting learning activities. In this stage is carried out by analyzing the level of effectiveness of the field laboratory in improving students' critical abilities.

3. Results and Discussion

The Analysis of the Area of Mount Galunggung for the Needs of Field Laboratory for Geography Education

The teaching and learning process with problem-solving aspects must be designed in such a way that it is able to stimulates critical thinking skills and encourage them to use their minds consciously to find solutions in problem-solving or to make decisions. Problem-solving learning is essentially learning to think or learning to reason, which is to think or to reason by applying previously acquired knowledge to solve new problems that have never been encountered.

Often the topic of geographical phenomena that is relevant to the life or environment of students becomes an interesting study in teaching and learning activities. (Butzow, 2019; J. Waite et al., 2017). Direct experience in the field gives a deep impression to learners, for example from studying landscapes. Landscapes can directly affect physical and human characters in the actions taken against phenomena that are seen visually. Physically, the landscape can provide an overview of land formations, landscapes, topography, vegetation, and diverse biodiversity that have interactions, interrelationships and interdependencies.

The Mount Galunggung area is located in Tasimlaya, West Java, Indonesia. The height of Mount Galunggung reaches 2,168 meters above sea level. The Mount Galunggung area has very diverse potentials, including: physical potential, biodiversity, social, tourism, agriculture, learning of volcanic disasters. By examining these potentials, it can be integrated to understand an area from a geographical point of view through a field laboratory model. Field laboratory models can be developed with the need to improve critical thinking skills. Figure 1 shows the object of research.

![Delineation of the Area of Mount Galunggung for Field Laboratory for Geography Education](image)

Figure 1. Delineation of the Area of Mount Galunggung for Field Laboratory for Geography Education
Field laboratory in this research is included in the integrated laboratory category. The laboratory can function as a place for learning, research, and community service activities. The results showed, there are five zones for the function of the field laboratory. Zones I, II, III and IV are designated for physical geography studies and zone V for social geography studies. The zoning delineation of Field Laboratory I - V can be seen in Figure 2. Laboratory zoning refers to indicators of location characteristics, infrastructure, methods, available tools, activities that can be carried out, outputs and outcomes for learning purposes.

![Zoning of the Area of Field Laboratory for Geography Education on Mount Galunggung](image)

**Figure 2.** Zoning of the Area of Field Laboratory for Geography Education on Mount Galunggung

**As a place for teaching and learning activities**

Mount Galunggung is often used from the level of elementary school, secondary school, higher education, or another educational institution. Based on observations conducted earlier, some of those activities can described in table 1.

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Outdoor learning process: Al-Fuqon High School, Tasikmalaya</td>
</tr>
</tbody>
</table>

**Table 1. Teaching and Learning Activities on Mount Galunggung**
As a place for research activities

Many research activities have been carried out in the area of Mount Galunggung. At least, based on the search results on the website https://scholar.google.com/ on June 21, 2020, by using the keyword “Galunggung”, researchers found a thousand more related reviews articles related. This indicated that the area of Mount Galunggung has a function as a place for research activities.

The role of the field laboratory in this study was as a means or place to conduct research either by using experimental or survey methods. Zulaikha (2015) explained that the roles of laboratories in higher education, namely (a) research facilities, (b) theory validation, and (c) developing various devices as outputs from various subjects. Field laboratories can function as a place to carry out research activities in accordance with the researcher's field of study that is tailored to the potential and carrying capacity of the laboratory. The Galunggung area has relevance to the field of Geography, including having a distinctive volcanic morphological phenomenon that can be studied from various geographic approaches.

As a place for community services

In terms of community service, Zulaikha (2015) explained that the roles of laboratories are (a) to assist students by becoming a facility for them who are taking practicum which requires them to go to society to apply the lesson they studied in the classroom, and (b) Laboratory as a means to facilitate activities. From this opinion, the laboratory can be used to apply knowledge, research results, research development results for the welfare of society. So that various findings from science and technology can be obtained easily by the community.

Based on preliminary observation and analysis and referring to the scope of laboratory management, namely 1) designing, 2) managing equipment and the utilization of materials, 3) maintenance of tools and materials for practicum activities, 4) evaluating working systems in the laboratory, and 5) developing laboratory activities. The scope of laboratory management is relevant to Puspita (2020) stated that laboratory management must be carried out with the stages of activities, namely 1) planning laboratory, 2) organizing laboratory, 3) implementing, 4) supervising, and 5) evaluating/assessing. So, the steps that need to be carried out in developing a field laboratory can be carried out by following the following steps: identification of potentials, building assumptions, constructing the developed model, analysis, interpretation, validation and implementation. Table 2 describe the studies that have been carried out on the suitability of the potential for field laboratories for geography.

<table>
<thead>
<tr>
<th>No</th>
<th>Indicators</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Content (Subjects that can carry out teaching and learning activities and practicums in the area of Mount Galunggung)</td>
<td>Physical Geography: Geology, Geomorphology, Hydrology, disaster mitigation, volcanology, Biogeography, Meteorology, Environmental Science, and Environmental Ecology. Social Geography: Agricultural Geography, Economic Geography, cultural geography, Tourism Geography, etc.</td>
</tr>
</tbody>
</table>
Availability of Infrastructure

1. Having accessibility, adequate and affordable transportation facilities and infrastructure.
2. Have the availability of equipment and materials that can be used for practicum, research, and teaching activities.
3. Having a classroom for evaluating field activities located in the Volcanology Post of Mount Galunggung

Organization

The organization for the management of the field laboratory of geography education in Mount Galunggung can collaborate with government agencies or non-governmental organizations. Furthermore, those that have confirmed willing to do so are as follows.

1. Siliwangi University (Department of Geography Education)
2. Volcanology Observation Post (Ministry of ESDM)
3. State Forestry Office
4. Regional Disaster Management Agencies of Tasikmalaya City and Tasikmalaya Regency
5. Geography Teacher Groups of Tasikmalaya City and Tasikmalaya Regency
6. Education Offices of Tasikmalaya City and Tasikmalaya Regency

Source: Observation Results, 2019

Functions and Roles of the Field Laboratory of Geography Education

In general, a laboratory is defined as a place to make observations, experiment a study, test something that is needed by an experiment, analyze data, and practice a certain science and skill. According to Indonesia’s Ministry of Education (2011), types of laboratories based on their functions, namely, research laboratories, analytical laboratories, test laboratories, and teaching laboratories. Learning activities in the laboratory can stimulate student curiosity, work skills in groups, be able to find research results for themselves, and can improve reasoning power for students to think critically. (Puspita, 2020). Therefore, the laboratory is a very important supporting facility in teaching and learning activities and needs special attention in its development.

When examined from the point of view of the building, laboratories are classified into several types, namely: open spaces, closed rooms (buildings), school gardens, greenhouses and others. The laboratory can be used as a place to carry out teaching and learning activities with clear instructional objectives and to help students learn more realistically. The laboratory is included in one of the learning infrastructure that is important for every school or college to have. This is in accordance with the learning objectives in the laboratory, namely improving the quality of learning and improving students’ practical skills. The laboratory also has a function and function as a place for scientific practicum activities, experimental activities, research, practical skills training.

Higher education laboratories have a fundamental role in improving the quality of the institution, especially in obtaining human resources who are independent, skilled, professional, and having high insight in each field of science that they are engaged in. Three laboratory roles in higher education institutions, namely (1) place for teaching and learning activities, (2) place for research activities, and (3) place for community services. This is in line with Indonesia’s Government Regulation No. 05/1980 Article 29, and Indonesia’s Government Regulation No. 60/1999 Article 2 states that there are 2. The role of the laboratory in higher education must be able to preparing students to be community members who have professional.

Field Laboratory for Geography Education and Students’ Critical Thinking Skills

The development of this field laboratory model is designed to train students to have critical thinking competencies. Gerace & Beatty (2005) stated that the critical thinking ability of a person does not depend only on the level of maturity but also on the problems they experience themselves. Practicum in the laboratory is an important part of learning science. The success of the practicum must be supported by several other factors, namely: teacher competence in the science learning process, laboratory management, facilities and infrastructure needed in the practicum.

21st-century competencies include life and career skills, innovation and learning skills which are later known as 4C (critical thinking, communication, collaboration, and creativity), and ICT (Yani & Ruhimat, 2018). Based on these competencies, 21st-century education must provide provisions for students so that they can achieve
success in terms of knowledge, career, and society (Llewellyn, 2013; Remziye Ergul et al., 2011; Trilling & Fadel, 2009).

The learning process in open spaces can provide experiences that are not found in the classroom. An open space that is used as a place of learning can contribute both to improving student abilities (Acar, 2014). The design and modeling of open spaces that serve as learning places for students is very important to be studied, because students can be free to do experiments, prove the theories obtained in the classroom, have the opportunity to develop critical thinking skills. Direct learning in the field provides good benefits for students, namely adding to experience and fostering learning motivation. Sinton (2017) argues that outdoor learning (in the field) can combine processes of spatial and critical thinking. The combination of both can be instilled with geographic skills, so that information literacy which is an important aspect in a geographic context can be obtained by students (Hulseberg & Versluis, 2017). Open space in the context of spatial thinking is what makes geography has unique characteristics in the object of study. The discipline of geography has deep relevance in the study of spatial thinking (Tate et al., 2005). Students who have spatial skills can do critical spatial thinking (Kim & Bednarz, 2013).

Competences regarding critical thinking have been tried to define by four latest researchers, namely Abrami et al. (2008), Chesterman (2014), and Ennis (1989). They all emphasized the importance of the conceptual structure of critical thinking both on the content and on the process (both teachers and students as thinkers). The concept of critical thinking has been applied in various disciplines with various studies and various approaches (Fawkes et al., 2005). A study conducted by Wallace & Jefferson (2013) developing thinking skills in new students can be carried out by utilizing the model of the workbook exercises.

The development of students’ critical thinking skills can be applied in the teaching and learning activities in the field, considering that critical thinking learning is an integration of several abilities, such as observation, analysis, reasoning, assessment, decision making, and persuasion. Critical thinking can be trained through the provision of meaningful experiences. These experiences can provide opportunities for students to study outdoors by designing a good teaching and learning process and maximizing the potential of an area to be developed into a model to serve as a field laboratory.

**Table 3. Stages of Critical Thinking in the Teaching and Learning Process in the Field Laboratory for Geography Education**

<table>
<thead>
<tr>
<th>Stages</th>
<th>Scope of Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>• Determining what information can be obtained&lt;br&gt;• Obtaining information from various sources&lt;br&gt;• Ascertaining what information is currently available&lt;br&gt;• Exploring various points of view&lt;br&gt;• Identifying similarities and differences</td>
</tr>
<tr>
<td>Analysis</td>
<td>• Outlining the gained information into themes or main arguments&lt;br&gt;• Discriminating the value of information&lt;br&gt;• Prioritizing important information&lt;br&gt;• Outlining the findings with field analysis</td>
</tr>
<tr>
<td>Contextualization</td>
<td>• Contextualizing information concerning historical possibilities, human&lt;br&gt;activities, ecology, environment, and so on</td>
</tr>
<tr>
<td>Asking</td>
<td>• Considering possible alternatives from the findings&lt;br&gt;• Developing new hypotheses</td>
</tr>
<tr>
<td>Reflection</td>
<td>• Asking and examining conclusions&lt;br&gt;• Conducting reflection towards possible impacts</td>
</tr>
</tbody>
</table>

From Table 3, it can be seen that critical thinking skills can be developed which has a function to build analytical skills, synthetical skills, identifying and problem-solving skills, concluding skills, and evaluating or assessing skills.

### 4. Conclusion

Developing the environment as a field laboratory can be used as a role model for outdoors teaching and learning activities. Learning and teaching activities at the Geography Education Field Laboratory that are well designed can provide a memorable and interesting learning experience for students, students can learn directly so as to minimize student misperceptions from discussing subject matter obtained in the classroom. Teaching and
learning activities in field laboratories also provide opportunities for students to build conceptual understanding, stimulate critical thinking skills, verify correct conceptualization, develop skills, foster scientific attitudes, develop collaborative skills, and train psychomotor abilities. Critical thinking skills that can be developed by utilizing field laboratory modeling are analysis skills, synthesis skills, identification and problem solving skills, conclusion skills, evaluation or assessment skills. The development of field laboratory models in other fields of study is needed to be used as science development.

5. Acknowledgment

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