EDUCATION AND LEARNING GEOLOGY: MOBILE LEARNING SYSTEM FOR GEOLOGICAL DATA COLLECTION IN THE FIELD

Intan Noviantari Manyoe[1)], Siti Suhartini S. Napu[2)], Muhamad Danial Suma[3)], Naafi Syahna Firdhaus Biya[4)], Ivan Taslim [5)]

[1)] Geological Engineering, Universitas Negeri Gorontalo, intan.manyoe@ung.ac.id
[2)] Geological Engineering, Universitas Negeri Gorontalo, sitinapu4@gmail.com
[3)] Geological Engineering, Universitas Negeri Gorontalo, danial.suma2000@gmail.com
[4)] Geological Engineering, Universitas Negeri Gorontalo, biyanafi@gmail.com
[5)] Geography, Universitas Muhammadiyah Gorontalo
ivantaslim@umgo.ac.id

A. Introduction

Education is a socially regulated process and is a transfer of experience that occurs continuously from generation to generation (Nazlev, 2017). Learning is a reflective activity that allows students to take advantage of previous experiences to understand and evaluate current conditions so that they can shape future actions and formulate new knowledge (Watkins, 2002).

National education has the aim of developing capabilities and shaping the dignified character of the nation's civilization in order to educate the nation's life (UU Sisdiknas Tahun 2003). This goal means that the success of education in Indonesia can be assessed from the learning outcomes that produce skills, character, intelligence in students. The education and learning process must have an orderly system and curriculum so that this goal can be achieved.

Each field of science has a learning system to achieve curriculum goals, according to the level of education. In earth science and technology education, such as geology, education and learning not only by delivering material in the classroom, but also needing a learning process such as laboratory and field practicum. Learning can be done with several media such as props, pictures, mock-ups, and technology applications. The learning media are a physical means of delivering learning material (Briggs, 1977) or as information that can be used for educational purposes (Schramm, 1977).

Culture, technology, and the economy affect a country's education system (Naziev, 2017). Geology education and learning entering the digital era have also been influenced by the presence of mobile learning-based technology applications.

B. Discussion

1. The Mobile Learning System uses Map Application

Geological education and learning in the field requires the use of tools and materials that function to determine coordinates, plot stations on base maps, describe outcrops/rocks, and document outcrops/rocks. The use of geological field equipment and geological writing instruments aims to facilitate data collection in the field.

In collecting field geological data, students and teachers/lecturers use tools and materials in the form of a Global Positioning System (GPS) receiver, base maps, field notebooks, pencils, markers and camera. GPS receiver functions to determine the coordinates of the observation station. Base map for plotting the data collection location based on the coordinates given by the GPS receiver. Field notebook and pencil to record descriptions of outcrops. Markers are used to mark observation stations on the map.

After arriving at the observation station or field geological data collection station, the students collected coordinate data using a GPS receiver. The GPS receiver will provide coordinated data in the form of latitude and longitude points. Students record coordinates data and plot the coordinates of the observation station on a map (Figure 1).

Figure 1. Retrieval of data in the field using commonly used methods. Students plotted the results of the reading of the coordinates from the GPS receiver on a base map.

Students plot the coordinates of the observation station by looking at the latitude and longitude coordinates on the map. The latitude and longitude coordinates printed on the outside of the map can be used to assist coordinate plotting. Guidelines can be drawn to determine the coordinates of the stations on the map. The intersection of latitude and longitude auxiliary lines is the coordinate point of the station (Figure 2). The coordinates of the observation station on the map can be marked with a marker.

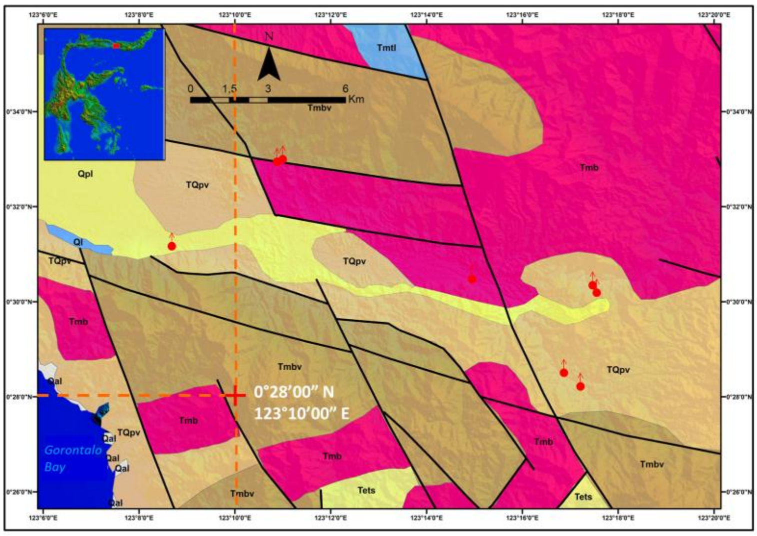

Figure 2. The coordinates of the station are obtained by the intersection of latitude and longitude on the map.

Geological data collection in the field carried out by students was followed by descriptions of outcrops and rock descriptions. Description of outcrops and rocks using geological writing instruments in the form of field notebooks and pencils. Field notebooks contain descriptions of outcrops, rock descriptions, measurement of structural data and sketches of outcrops. The final stage is the observation station documentation in the form of taking pictures of the outcrops and other geological features on the outcrops.

The advantage of the geological data collection method that is commonly used is that students will have the ability to operate a GPS receiver. Plot of coordinate points on the map using guide lines can train students to better understand basic map knowledge. The drawback of collecting data in the field using common methods is that it takes inefficient time from taking coordinates to plotting coordinate points on the map.

As the world enters the digital era, the concepts of education and learning also have an influence. Mobile phones and technological applications create new things and new ways that are unimaginable (Sharma, 2019). The methods of collecting geological field data using GPS receivers, base maps, markers, and geological writing instruments, in the digital era are present in the form of a mobile learning system application.

One of the mobile learning systems in the field geological data collection comes in the form of a map application. Many mobile learning systems for map applications are provided free of charge in downloader applications. Students can download the map application easily. One of the application maps that can be used in the field is Pdf Maps.

Use of a map application by creating digital maps that are saved in Pdf format. Maps can be created using a Geographical Information System (GIS) application or can be downloaded maps in Google Earth. Digital maps that are already in pdf form are added to the map application. There are map applications that can be done by having to be connected to an internet connection and some can be used even though it is offline. Geological data collection using the Pdf Maps application can be done offline.

When the students arrive at the observation station, the student's position has been plotted on the map. The storage of observation station points is done by marking the observation station points (Figure 3). The placemark feature on the map application is used to store observation station points. The position of students who move from one station to another, is indicated by pressing the placemark feature. All stations marked with the placemark feature have been recorded on the map application. Storing observation station points replace the work of students using a GPS receiver to get location coordinates and manually plotting station coordinates on a map.

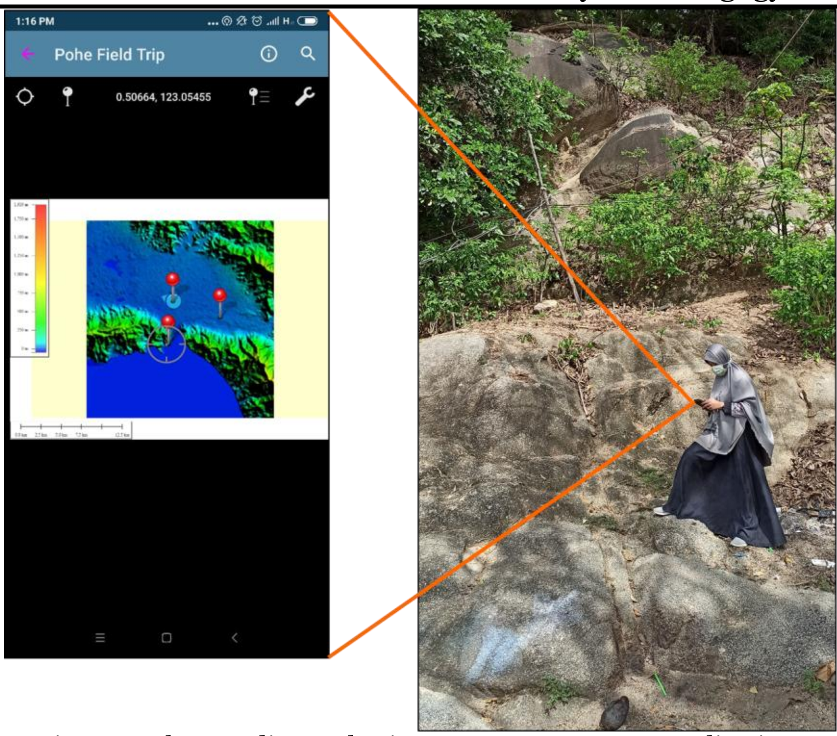

Figure 3. The coordinate plotting process uses a map application.

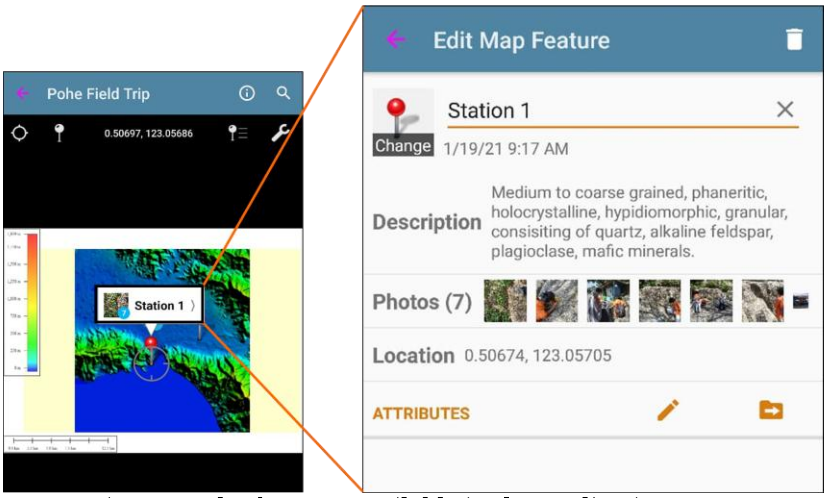

Figure 4. The features available in the application map.

The features that can be used further on the application map are description and documentation (Figure 4). Feature description is used to write the condition of the outcrop and macroscopic observations of rocks at the observation station. The description feature on the application map replaces the function of geological writing instruments, namely field notebooks and pencils. Another feature is photos. The photos feature is used to store the results of the documentation of outcrops, rocks and geological structures at observation stations. The photos feature replaces the camera function in general geological field data retrieval.

The advantage of a map application is that it provides various features that can replace geological tools and materials such as GPS receivers, geological writing instruments, and cameras. Students who use the application map can use time efficiently when collecting field geological data. The drawback of a map application is that students lack manual map reading skills. The battery charge of a mobile phone can also affect geological data collection.

2. Mobile Learning System using Geological Sample Application

Field notes are the essence of research results and field surveys of a student or geologist. Retrieval of geological data and features in the field using notes or field books is very important and must be done when in the field. The goal is to record the history and geological traces that exist in an area. Naturally, data collection and geological features are carried out by recording geological data in field book sheets that already have an ordered and systematic format.

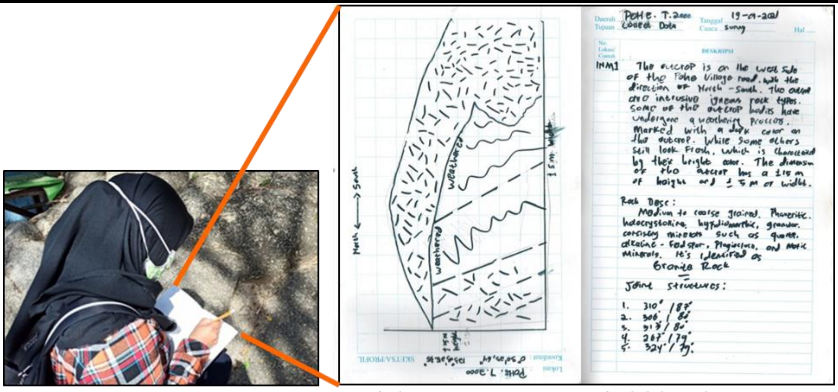

Figure 5. Description of the outcrop using field books.

In using field books, students are required to write all forms of data from their observations and interpretations into field notes. This is done by manually writing using a writing tool in the form of a pencil or pen. The next activity is depicting outcrop sketches to identify and clarify the two-dimensional state of the outcrop (Figure 5).

The use of conventional field notes actually creates a little dilemma that can be felt by students when they are in the field. These dilemmas can range from efficiency when taking notes in field books which take a lot of time with the ability of field paper sheets that are easily damaged or torn when exposed to water. By seeing this, it does not require the possibility of a student to do it through a mobile learning system.

The mobile learning system is a learning system using software applications that can be accessed by mobile phone users anywhere and anytime. Field Geologist is a software that is devoted to helping student's record and create descriptions of outcrops and rocks in the field by relying on smart devices or commonly called smartphones on the Android operating system.

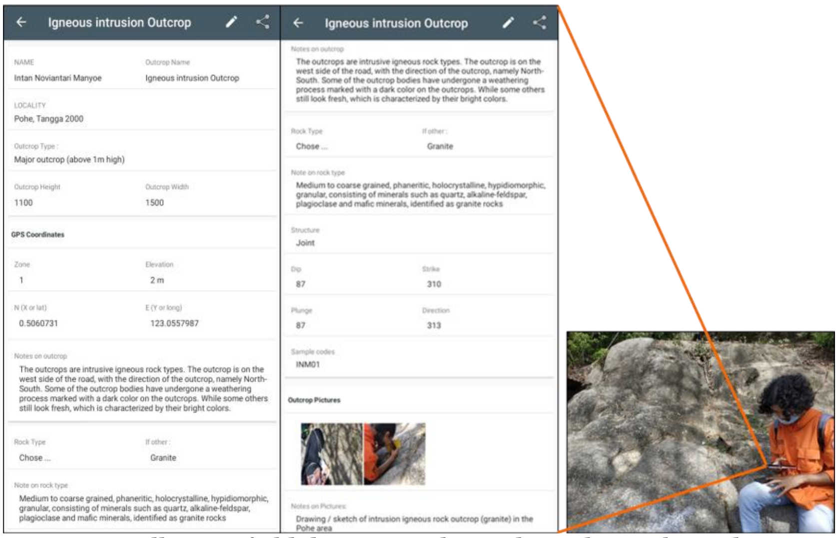

Figure 6. Collecting field data using the geological sample application.

As a tool that is used to increase the efficiency of recording in the field, the geological sample application is basically not much different from the situation when we record geological data and features in geological field notes or books. The features provided in the geological sample application have covered all important aspects of the geological field book. There are several additional features that make it easier for students to be able to integrate some descriptive data such as outcrop descriptions, rock descriptions and picture descriptions in one project field (Figure 6).

The Field Geologist application is carried out by selecting the type of outcrop option according to the outcrop found in the field. There are several menu options offered to mobile phone users, including five menu options for rock descriptions, namely igneous rock, metamorphic rock, sedimentary rock, alluvial sediment and stream sediment. There are additional options in the main menu of this application, namely the core logging menu and geology games.

Students choose the appropriate menu options and in accordance with the outcrops to be observed in the field. The application will provide a description table with a description format of each rock. The descriptive features provided include the name of the student, the name of the outcrop, the name of the area, the type of outcrop, the height and width of the outcrop, the GPS coordinates (can be adjusted automatically using the built-in GPS on the mobile phone), the height from sea level, the record of the description of the outcrop, the type of rocks, rock description records, structure types, structural measurements, sample codes. The application provides an outcrop image documentation feature which is equipped with a description note of the outcrop image.

The application provides a menu of additional tools, namely secondary informative features about geology. The tools provided include basic color charts, dip and strike measurement, geologic time scales, grain sizes, layering types, macrofossil types, Mohs hardness scale, plunge and trend measurement, rock identification, types of faults, types of folds, and types of grading in beds.

The advantages of this application are that it is able to manage and personalize field data properly and has features that are quite complete in helping students' record observational data. Time efficiency in the collection is also quite good compared to data collection using field notes. The drawback to this data collection method is accessible to applications that are affected by mobile phone battery power.

3. The Mobile Learning System uses the Geological Structure Application

Data collection in the field is carried out to collect structural geological data. Students generally use a compass to make structural measurements. One of the mobile learning systems for structure measurement is using the Geoclino application (Figure 7).

Figure 7. Structural geological data collection. a) Data collection using a compass, b) Data collection using mobile learning, c) The results of data measurement on the mobile application.

As a mobile application, GeoClino has several advantages over measuring structures using a compass. Some of the advantages of using the GeoClino application are reducing the number of items brought to the research location, time efficiency when collecting data in the field, easy operation, and can record up to 100 data (locations, strikes and dips). Mobile learning can be used for measuring structures that require a lot of data not only in learning but in structural geological research (Usman et.al, 2018).

Geoclino has several drawbacks when compared to the method of measuring geological structures using a compass. Some of the disadvantages of using the GeoClino application are high power consumption due to the use of sensors simultaneously, and the relative compatibility of the phone with the measurement object, depending on the size of the device used.

Measurement using a compass and using Geoclino has a large time difference. The results of measurements using a compass and Geoclino have a low difference. The results of measurements using the mobile learning system are very dependent on the alignment of the device with the structural plane in the rock. Several factors can cause the error of the measurement results, including the misalignment of the devices when measuring the structure. Misaligned devices are caused by bumpy rock surfaces.

C. Conclusion

Geology education and learning cannot be separated from the effects of advances in educational technology. The mobile learning system is a technology application that can be used for geological data collection in the field. The availability of technological applications for geological data collection can be found in the form of map applications, geological sample applications, and geological structure applications. Mobile learning systems for geological data collection in the field have advantages in time efficiency, availability of complete geological features, accuracy of observation results, and easy operation. The use of mobile learning systems can be an alternative in geology education and learning, but students' basic understanding of geological maps, directions, and structures should still be a concern for teachers or lecturers.

References

1. Briggs. 1977. Instructional Design Educational Technology Publication. New Jersey.
2. Naziev, A. (2017). *What is an education?* In Conference Proceedings. The Future of Education (p. 436). libreriauniversitaria. it Edizioni.
3. Undang-Undang Tahun 2003 Tentang Sistem Pendidikan Nasional.
4. Schramm. 1977. *Big Media Little Media*. London: Sage.
5. Usman, F. C. A., Manyoe, I. N., & Duwingik, R. F. (2018). Rekonstruksi Tipe Longsoran di Daerah Gorontalo Outer Ring Road (Gorr) dengan Analisis Stereografi. Jurnal Geomine, 6(1).
6. Watkins, C., Carnell, E., Lodge, C., Wagner, P., and Whalley, C. (2002). Effective Learning. *In Research Matters series* (chapter: Effective Learning). London: University of London Institute of Education.

Glosarium

Geology	:	Study of the earth, its composition, structure, physical properties, history, and the process of its formation.
Geological Structure	:	A scientific discipline that is concerned with rock deformation on both a large and a small scale and focuses on the result of the strong tectonic forces that occur on the earth.
Strike	:	The direction of the rock bed seen from the compass angle.
Dip	:	Cut angle between the rock layers and the surface of the earth.
GPS	:	Global Positioning System, a navigation satellite system and positioning of a place.
Mobile Learning System	:	A learning model/method that adopts the development of cellular technology and mobile device.
GIS	:	Geographic Information System. A computer-based system that is usually used to store, and analyze geographic information.

Curiculum Vitae

Intan Noviantari Manyoe

Born in Limboto, Gorontalo. Intan holds a bachelor's degree in Geophysics and a master's degree in Geological Engineering from Hasanuddin University. Intan is a lecturer in the Geological Engineering major, Universitas Negeri Gorontalo and Head of the Geological Engineering Laboratory. The main focus of his research is renewable energy/geothermal, geotourism, geophysics and geological hazard.

Intan participated in a young lecturer apprenticeship program carried out by the Directorate General of Higher Education at Universitas Gadjah Mada in 2009. She participated in geothermal trainings conducted by the Ministry of Energy and Mineral Resources, UGM, ITB, Utrecht University, The Netherlands Organization for Applied Scientific Research and Geothermal Capacity Building Indonesia-Netherland in 2017. She joined in international collaborative research in the field of eco-geotourism with the Research Institute for Humanity and Nature, Kyoto, Japan and joined in geothermal scientific writing with lecturers at the Institute Technology of Petronas (ITP), Malaysia.

Intan received several awards, including a certificate of commendations from three Japanese professors; Dean of FMIPA, Rector of UNG; Directorate General of Higher Education; and the President of the Republic of Indonesia. Communication with Intan via email intan.manyoe@ung.ac.id or website www.intanmanyoe.com.

Siti Suhartini S. Napu

Born on September 4, 1997 in Kabila, Gorontalo. Siti earned a bachelor's degree in Geological Engineering from Universitas Negeri Gorontalo. Active in the organization, including the general secretary of the Student Council of SMP Negeri 1 Kabila, the Board of Supervisors of the PERHIMAGI Organization (Association of Indonesian Geology Student Associations) UNG Commissariat, members of the SM-IAGI socialization division (Student Section of the Indonesian Geological Expert Association) UNG Commissariat, and the general secretary of Geological Engineering Student Association (HMTG) UNG.

Work experience as an assistant coordinator for the Geological Engineering Lab , a geopark research enumerator funded by BAPPEDA Gorontalo Province, and an individual consultant at the SNVT for Housing Provision of Gorontalo Province, Ministry of PUPR. Siti is an award winner in the field of scientific writing. Siti is a journal writer and speaker at international conferences.

Muhamad Danial Suma

Born on July 9, 2000. Danial is a student of the Geological Engineering major, Universitas Negeri Gorontalo. Danial is a recipient of PKM (Student Creativity Program) funding in 2019 and PHP2D (Village Development and Empowerment Holistic Program) in 2020 from the Ministry of Education and Culture. Danial participated in the Indonesian Archipelago Student Exchange Program-Credit Transfer System with Information Technology (PERMATA-SAKTI) at the Institut Teknologi Sepuluh Nopember, Surabaya and the International Credit Transfer Program (TKI) at Ehime University, Japan.

Naafi Syahna Firdhaus Biya

Born in Gorontalo on September 5, 2000. Naafi is a student at the Geological Engineering major, Universitas Negeri Gorontalo. Naafi has participated in the Village Development and Empowerment Holistic Program (PHP2D) as a member along with 12 other Geological Engineering students. This program was implemented for 6 (six) months in Botubarani Village, Bone Bolango Regency. Naafi participated in the PERMATA SAKTI program at the Institut Teknologi Sepuluh November Surabaya and the International Credit Transfer (TKI) at Ehime University, Japan.

Ivan Taslim

Ivan comes from Luwu Timur Regency, South Sulawesi. Ivan completed his Bachelor of Science and earned a Masters in Engineering at Hasanuddin University. Ivan was appointed as a lecturer at the major of Geography, Faculty of Science and Technology, Muhammadiyah University of Gorontalo and is a special staff of the Regent of Gorontalo Regency. The main focus of his research is Hydrology/Hydrogeology, Disaster Risk Reduction, and the field of Earth Sciences using GIS technology & Remote Sensing.

Ivan is a member of the U-Inspire Indonesia community and a researcher for the USAID SHERA (Sustainable Higher Education Research Alliance) program. Ivan attended international training, including those held by the Asian Institute of Technology, the Geoinformatics Center in Bangkok, Thailand and the Institute of Mountain Hazards and Environment, Chinese Academy of Science in Chengdu, P.R. China.

Ivan is open to collaborating in research and community service by means of communication via email: ivantaslim@umgo.ac.id /ivantaslim@gmail.com.