Research Article

Developing local-based invertebrates e-encyclopedia to improve scientific reasoning skills

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ABSTRACT

Acknowledging that it is one of the important of 21st Century skills, scientific reasoning skills have been developed in various ways. However, the development based on local potential has not been optimally explored yet. The aim of this research was to produce e-encyclopedia of invertebrates based on local potency to improve students' scientific reasoning skills. This research and development was done, based on Lee and Owen development model, between July and December 2019. This research involved 29 students of Biology Department, Universitas Negeri Malang who have passed their third semester. The validity of e-encyclopedia was determined by conducting expert appraisal consisted of the instructional and technical review. The assessments towards e-encyclopedia was done to decide its validity, practicality, and effectiveness. Furthermore, the students' scientific reasoning skills were measured using pretest and posttest. The validity data obtained were analyzed descriptively using percentage, while students' scientific reasoning skills were analyzed using gain scores. The results showed that the percentage values were 84.72 for content validity (valid), 98.10 for media (very valid), 87.41 for technical (very valid), and 84.47 for practicality (valid). In addition, the students' scientific reasoning skills were classified as effective based on the gain scores achieved in each indicator i.e. 0.44 (argumentation), 0.43 (existing knowledge), 0.38 (methodology), 0.40 (analysis), and 0.42 (drawing conclusions). Thus, the e-encyclopedia developed is effective to improve students' scientific reasoning skills.

INTRODUCTION

Exploration of the southern coast in the Malang Regency is increasing in line with the development of tourism. Various potential local resources that stretch along the coastline attract the attention of many researchers. Research related to regional characteristics (Semedi et al., 2019), ecotourism development (Harahab & Setiawan, 2017; Riniwati et al., 2017), disaster mitigation (Nugroho & Sucipto, 2020), local-wisdom (Rahmaniar et al., 2019), and biodiversity (Purnomo, 2020; Sari et al., 2015) has opened up the

potential of coastal areas in South Malang. However, those research's development as a learning resource has not been optimally carried out into a paradox. Kondang Merak Beach, one of the areas on the South Coast, has quite a high diversity of invertebrates.

The beach characteristic is quite calm and surrounded by peaks and coral rocks to protect the coastal ecosystem (Nugraha et al., 2016). These characteristics are very distinctive because most beaches in the southern region are steep, rocky, and have cliffs. This uniqueness makes the coral reef population at Kondang Merak Beach avoid the swift waves and currents from the open waters (Nugraha et al., 2016). Various groups of Coelenterates and Mollusca are reported to have been found along the southern coastline (Luthfi et al., 2017; Luthfi et al., 2018). The high level of biodiversity is an essential asset in conserving natural resources, one of which is through the development of learning resources based on local potential (Kundariati et al., 2020; Kurniawati et al., 2017; NEA, 2010).

The utilization of resources as local potential is a strategic step that provides many benefits. (Ardan, 2016; Parmin et al., 2015) reported that the utilization of local potential as a learning resource had a significant impact on students' knowledge. Moreover, it is easier for teachers to link learning skills or competencies with the student learning environment (Donnelly et al., 2017; Hussin, 2018). The utilization of local potential can also be directed as an effort to support 21st Century learning (Binkley et al., 2012; Hussin, 2018; Jumriani & Prasetyo, 2017). Some researchers state that the integration of local potential as a learning resource can facilitate students in scientific reasoning (Glaze, 2018; Kambeyo, 2017; Ogunkola, 2013). These efforts help students build cognitive understanding in a more profound way (Daryanti et al., 2015).

However, Erlina et al (2018) show that students' scientific reasoning skills are still low. Even though scientific reasoning skills are one of the skills that students must have, referring to the profile of 21st Century students (Kambeyo, 2017; Khoirina et al., 2018; Kuhn, 2010). Scientific reasoning skills in question refer to students' ability to analyze, express opinions, and draw conclusions based on their understanding (Rhodes, 2010). Furthermore, these three components will lead to making the right decisions based on relevant evidence (Abosalem, 2016; Freidenreich et al., 2011; McNeill et al., 2012).

This research aims to develop an e-Encyclopedia of invertebrates as a learning resource based on the local potential of Kondang Merak Beach. The e-Encyclopedia draft that has been developed is then tested to measure the students' ease and usefulness. The effectiveness test is used to determine whether the product developed supports learning in improving students' scientific reasoning. The results of this study are expected to contribute to the development of instructional media that improve thinking skills based on local potential.

METHOD

This research consists of exploratory research and media development while it was conducted from July to December 2019. The exploratory research was conducted at Kondang Merak Beach, Malang Regency. Sampling was carried out using free-roaming techniques to ensure that no specimen was left behind. Product development refers to Lee and Owens (2004) model, which is correctly used to develop multimedia-based products. The stages of development carried out consist of: assessment/analysis; design; development; implementation; and evaluation.

The subjects in this study were lecturers and students of Biology Education Department the year 2018 State University of Malang. The types of data contained in this study consists of qualitative and quantitative data. The qualitative data were obtained from experts and practitioners, while the quantitative data were obtained from assessments by validators and students as users. The assessment is carried out using a rating scale and students' scientific reasoning scores. The data collection instruments consisted of instruments of validity, practicality, and effectiveness. The results of the product evaluation questionnaire were analyzed using descriptive analysis in the form of a percentage. The criteria for product validity and practicality (Table 1) refer to Gay et al (2012).

Table 1. Product validity assessment qualification criteria

Practicality	Percentage (%)	Validity
Very practical or can be used	85.01 - 100	Very valid or can be used
Pretty practical or can be used but needs a little revision	70.01 – 85.00	Quite valid or can be used but needs a little revision
Less practical, it is recommended not to use it because it needs a lot of revisions	50.01 – 70.00	Invalid, it is recommended not to use it because it needs a lot of revisions
Impractical or may not be used	01.00 – 50.00	Invalid or may not be used

The effectiveness of the e-encyclopedia in improving students' scientific reasoning was measured using the gain score formula. The effectiveness criteria used refer to Erlina et al (2018), are the products presented in Table 2.

Table 2. Product effectiveness criteria

Level of achievement in value	Level of effectiveness
n-gain ≥ 0.7	Very effective
0.3 < n-gain < 0.7	Effective
n-gain ≤ 0.3	Not effective

RESULTS AND DISCUSSION

The local potential has the unique characteristics of each region (Parmin et al., 2015). Malang Regency has the potential for biodiversity that can be optimized as a learning resource (Kundariati et al., 2020). Local potential-based learning can provide a more valuable experience for students because it is closer to everyday life and the environment. In line with research conducted by Hernawati et al (2018); Koban et al (2020); and Kurniawati et al (2017) concluded that learning assisted by learning sources with local potential could improve students' academic abilities. Local potential-based teaching materials also help students classify activities and improve attitudes in preserving sustainability (Lestari et al., 2018).

The exploration results showed that eight species of Coelenterates were found at Kondang Merak Beach (Table 3). Five of them are of the genus *Montipora* (three species) and *Pocillopora* (two species). Meanwhile, there are 17 species of Mollusca consisting of 15 genera. More specifically, *Conus* and *Engina* are two species each.

Table 3. The results of exploratory research on the Kondang Merak Beach

Phylum	Species
Coelenterates	1. *Pocillopora damicornis (Linnaeus, 1758)*
	2. *Pocillopora verrucosa (Ellis & Solander, 1786)*
	3. *Montipora digitata (Dana, 1846)*
	4. *Montipora carinata (Nemenzo, 1967)*
	5. *Montipora capricornis (Veron, 1985)*
	6. *Galaxea fascicularis* (Linnaeus, 1767)
	7. *Hydnophora exesa (Pallas, 1766)*
	8. *Porites lutea (Milne Edwards & Haime, 1851)*
Mollusca	1. *Conus planorbis (Born, 1778)*
	2. *Conus achanitus (Gmelin, 1791)*
	3. *Engina mendicaria (Linnaeus, 1758)*
	4. *Engina bidentata* (Menke, 1843)
	5. *Atria pectinata* (Linnaeus, 1767)
	6. *Geloina expansa (Mousson, 1849)*
	7. *Monetaria annulus (Linnaeus, 1758)*
	8. *Naria erosa (Linnaeus, 1758)*
	9. *Turbo bruneus (Roding, 1798)*
	10. *Euplica varians (G.B. Soweby, 1832)*
	11. *Eunaticina papilla (Gmelin, 1791)*
	12. *Tonna canaliculata (Linnaeus, 1758)*
	13. *Tanea undulata (Roding, 1798)*
	14. *Rochia nilotica (Linnaeus, 1767)*
	15. *Conomurex lahuanus (Linnaeus, 1758)*
	16. *Pictocolumbella ocellata* (Link, 1807)
	17. *Onchidoris billamelata* (Linnaeus, 1767)

The Coelenterates and Mollusca species found were used as learning resources in the development of the e-encyclopedia. The results of the validation of material experts and practitioners show that product feasibility and readability are classified as very valid, respectively 84.72% and 87.41%, as described in Table 4. The validation of media and technical experts showed similar results. An assessment of four media validity aspects shows that the e-encyclopedia is very valid (98.10%). More specifically, the linguistic and graphic aspect is very valid, with a percentage of 100% (Table 5).

Table 4. Validation test results by material experts and practitioners

Expert	Aspect	Number of aspect	Maximum score	Acquisition score	Validity (%)	Average (%)	Category
Material	Content eligibility	16	80	71	88.75	84.72	Quite valid
	Legibility	11	55	48	87.27		
Practitioners	Content eligibility	16	80	69	86.25	87.41	Very valid
	Legibility	11	55	49	89.09		

Table 5. Validation test results by media experts

No	Aspect	Number of aspect	Maximum score	Acquisition score	Validity (%)	Category
1	Format	5	25	24	96.00	Very valid
2	Language and readability	6	35	35	100.00	Very valid
3	Presentation	3	25	24	93.33	Very valid
4	Graphic	3	30	30	100.00	Very Valid
	Average score				98.10	**Very valid**

In line with the expert's validation results, the product practicality test showed that the e-encyclopedia was feasible to be used as a learning media. Aspects of legibility, and benefits are classified as very practical with the percentages, respectively 87.65 and 85.66 (Table 6).

Table 6. Practical test results

No	Aspect	Number of aspect	Maximum score	Acquisition score	Validity (%)	Category
1	Language	5	575	484	84.17	Pretty practical
2	Legibility	5	575	504	87.65	Very practical
3	Presentation	8	920	749	81.41	Pretty practical
4	Display	6	690	556	83.48	Pretty practical
5	Benefits	6	690	591	85.66	Very practical

Data on scientific reasoning skills are obtained through pretest and posttest, which are integrated with scientific reasoning indicators. The measurement of the effectiveness of the product developed is to measure the increase in students' scientific reasoning skills using an N-gain formula. The results of improvement in each indicator of scientific reasoning skills are presented in Figure 1.
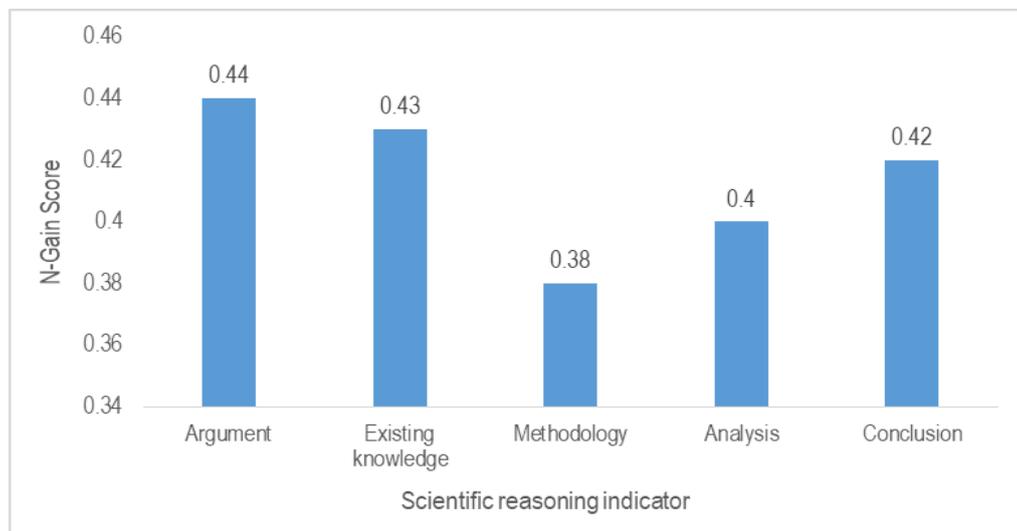

Figure 1. The N-gain score for scientific reasoning indicator

The integration of scientific reasoning skills in the development of the e-encyclopedia aims to streamline the measurement of students' thinking skills (Kambeyo, 2017). The integration of thinking skills is indicated to train students to develop their logical abilities. This prediction can be seen in the achievement of the students' N-gain scores after using the e-encyclopedia. Learning activities designed to guide the optimization of the concept of a scientific phenomenon that is owned, in this case, related to Coelenterates and Molluscs,

facilitate students in developing scientific thinking skills. This association is a very fundamental step to provide a more in-depth learning and thinking experience (Larsson, 2017; Tal & Tsaushu, 2017). Many researchers said that the scientific approach requires coherence between observing skills, asking, gathering information, analyzing information, associating, and communicating again (Glaze, 2018; Nurafifah et al., 2017; Salter & Atkins, 2014; Vieira et al., 2017).

Figure 1 shows that the e-encyclopedia effectively increases students' scientific reasoning—the students' ability to convey arguments increases through learning using the e-encyclopedia. The developing product facilitates students in identifying fundamental topics that have not been explored previously (Rhodes, 2010). Material characteristics related to diversity and classification principles encourage students to think logically. One of the students' arguments was morphological and anatomical features of animals belonging to Coelenterates and Mollusca. Students from observations obtained morphological and anatomical characteristics during the learning process. Observing in a scientific approach is an activity of sensing using various media such as images, videos, and wet and dry specimens (Retno & Yuhanna, 2016; Sukarno et al., 2013).

Increasing students' ability to argue is supported by the knowledge they have (Baker et al., 2010; Cullen et al., 2018; Darling-Hammond et al., 2020; Noviyanti et al., 2019). Knowledge is one of the critical elements in synthesizing information in depth (Darowski et al., 2016; Kastner et al., 2012; Kiili & Leu, 2019; Lundstrom et al., 2015; Palmatier et al., 2018), supported by various relevant and credible sources (Rhodes, 2010). Thus, students can see a phenomenon more comprehensively (Ennis, 2011; Goldman et al., 2014). It has an impact on the ability to do analysis and draw conclusions. However, the study results shows that the improvement in analysis indicators is lower than the ability to argue, know, and draw conclusions. Information synthesis skills are essential in revealing patterns, differences, or similarities in the concepts studied, in this case, Coelenterates and Mollusca. An improved analysis is lower because it requires deep understanding and thought related to investigations, practicum, and theory. Animal classification material requires students to find or criticize the basic concepts of grouping animals. The basis for classifying each phylum or class is unique, so students need to analyze it through hands-on activity activities (Cinici, 2013; Kuhn, 2011). Most of them mention morphological or anatomical features that are not related to these animals' primary classification.

Furthermore, methodologies are an indicator with an N-Gain score that best develops the theoretical framework skillfully (Leow & Neo, 2014; Yusof et al., 2012). This step needs to be formulated by students in describing and classifying animals. In this case, the description and grouping of animals are based on similarities or differences in animals' morphological and anatomical features.

The Coelenterates and Mollusca e-encyclopedia design consists of: a) scientific names, b) morphological descriptions, c) distribution, and d) conservation status accompanied by either original pictures or photos. It aims to help students obtain information as material for analysis in learning activities. In line with the statement of Hernawati et al (2018) that encyclopedia can provide visualizations to represent explanations. Apart from that, the e-encyclopedia also features synthesis and analysis. In other words, the description of species in the e-encyclopedia supports analyzing activities through student worksheets. According to Cinici (2013) analysis activities carried out by students are related to animal classification, where morphological characteristics can be used as the basis for animal classification.

As a mobile learning media, the e-encyclopedia has the advantage that it can be used flexibly by merely opening a smartphone. Mobile-based learning has been used for about 20 years in several countries (Akopian et al., 2013; Alhassan, 2016; Klimova, 2019; Sung et al., 2016; West, 2015) and provides benefits because of that flexibility (Behera, 2013; Cheung, 2015; Klimova, 2019; Miangah & Nezarat, 2012; Mileva, 2011). Currently, the use of smartphones has become commonplace, including their use in the learning process (Akopian et al., 2013; Klimova, 2019).

Smartphone applications are useful for improving higher education learning performance by implementing mobile learning-based learning (Demir & Akpınar, 2018; Elkhateeb et al., 2019; García-Martínez et al., 2019; Klimova, 2019; Ocran et al., 2020; Romero-Rodríguez et al., 2020; Sukardia et al., 2020; Sung et al., 2016). Learning using mobile learning can provide students with experiences and how they use mobile learning as a learning medium. It is in line with Cheung (2015) statement, which states that mobile learning can provide learning experiences and attract more students. Students who use applications on smartphones are also stimulated in formal and informal learning situations (Miangah & Nezarat, 2012; Teodorescu, 2015). In other words, students will be able to learn inside and outside the classroom. Student activities outside the classroom can be a means of contextual learning for students.

CONCLUSION

The development of the E-encyclopedia Coelenterates and Mollusca results from exploratory research at Kondang Merak Beach, is valid, practical, and effective to improve students' scientific reasoning skills. The results of the N-gain calculation show that all indicators of scientific reasoning skills are classified as effective. Further development can be done by integrating a more comprehensive thinking skills assessment.

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