Development of Science Learning E-Module with Online Media on Water Pollution Matter in Lake Tondano

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Abstrak

Pencemaran air di Danau Tondano sangat terkait dengan materi pelajaran IPA di sekolah menengah pertama tentang pencemaran lingkungan. Penelitian ini bertujuan untuk menghasilkan e-modul pembelajaran IPA dengan media online pada materi pencemaran air di Danau Tondano yang layak dan efektif. Jenis penelitian pengembangan ini mengacu pada model pengembangan Borg and Gall. Teknik pengumpulan data menggunakan wawancara, angket, dan tes. Instrumen penelitian menggunakan lembar wawancara, angket validasi produk, angket kepraktisan produk, dan tes hasil belajar. Hasil penelitian menunjukkan bahwa: (1) uji validitas oleh ahli media pembelajaran memperoleh skor sebesar 94% termasuk dalam kategori sangat valid (tidak perlu revisi); (2) uji validitas oleh ahli materi menunjukkan nilai 91% termasuk dalam kategori sangat valid (tidak perlu revisi); (3) uji coba terbatas pada kelompok kecil menunjukkan nilai 88% dan termasuk dalam kategori sangat praktis; dan (4) skor rata-rata hasil belajar siswa sebesar 77% termasuk pada kategori efektif. Berdasarkan penelitian yang telah dilakukan, maka e-modul IPA dengan media online pada materi pencemaran air di Danau Tondano dinyatakan layak dan efektif untuk digunakan oleh siswa.

Kata Kunci: E-modul, Pencemaran Air, Danau Tondano, Pendidikan IPA

Abstract

Water pollution in Lake Tondano is closely related to science subjects in junior high school on environmental pollution matter. This research aims to produce science learning e-modules on water pollution in Lake Tondano with online media that are feasible and effective. This type of development research refers to the Borg and Gall development model. Data collection techniques used interviews, questionnaires, and tests. The research instruments used interview sheets, product validation questionnaires, product practicality questionnaires, and learning outcomes tests. The results showed that: (1) the validity test by learning media experts obtained a score of 94%, included in the very valid category (no need for revision); (2) the validity test by material experts showed a score of 91% included in the very valid category (no need for revision); (3) limited trials in small groups showed a score of 88% included in the very practical category; and (4) the average score of student learning outcomes of 77% included in the effective category. Based on the research that has been conducted, the science e-module with online media on water pollution material in Lake Tondano is declared feasible and effective for students to use.

Keywords: E-modules, Water Pollution, Lake Tondano, Science Education

Introduction

Lake Tondano is the largest natural lake in North Sulawesi (Ruitan et al., 2023). Lake Tondano is located in the upper part of the Tondano River, which is located in Minahasa Regency. The location of Lake Tondano is at an altitude of ± 600m above sea level (from sea level), and the waters of Lake Tondano are 51,000 ha (Manu, Baroleh, & Kambey, 2012; Tamanampo & Bataragoa, 2017). The inlet (river that enters) is from several large and small rivers, most of which are seasonal rivers. Apart from rivers, other water sources are irrigation canals and residential canals. The outlet (the river that comes out) has only one channel, the Tondano River, which empties Manado Bay (Sittadewi, 2008).

Over time, the area around Lake Tondano has been used as residential land, agricultural land, household waste disposal, fish farms, and tourist attractions (Lumingkewas, Rombang, Kalangi, & Saroinsong, 2013). In addition, the lake water that comes out through the Tondano River is utilized for the Hydroelectric Power Plant (PLTA). Residential, agricultural and industrial wastes have contributed many nutrients, especially phosphate and nitrate, to the lake. In addition, fishery techniques using KJA (Floating net cages) cause a lot of excessive feed ingredients to settle and break down into high-nutrient sources. This nutrient enrichment in the waters has triggered the growth of aquatic flora in the lake, such as water hyacinth (*Eichornia crassipes*). Water hyacinth, as a floating plant, has covered a large area in Lake Tondano; it is estimated that it reaches about 20% of the lake area (Sittadewi, 2008). The fast growth and high density of water hyacinth cause this plant to be considered a weed that can damage the aquatic environment.

According to Jeujanan (2019), the increase in the degree of water acidity (pH) for polluted water is caused by the content of organic acids originating from the disposal of food scraps, dishwashing waste from restaurants and the disposal of household waste directly into Lake Tondano. The degree of acidity increases due to weak acid compounds such as HPO_4^{-2}, HCO_3^- and CO_2. Siltation, decreased water discharge, and decreased water quality are the main problems in the aquatic ecosystem of Lake Tondano (Telaumbanua et al., 2023). On the other hand, the biodiversity that lives in Lake Tondano depends on the carrying capacity of the environment (Manampiring, Mamahit, & Posumah, 2023).

Environmental pollution is the entry or inclusion of substances and other components into the environment so that the change in the environmental order by human activities or natural processes so that the quality of nature decreases and does not function according to its designation (Siregar & Nasution, 2020). Environmental pollution, especially water pollution in Lake Tondano, is very interesting to be used as a real lesson to be studied and developed in science learning. It is very useful for science learning for junior high school students who live around Lake Tondano. Lake Tondano can be a popular learning resource because it is one of the tourism icons in North Sulawesi (Masloman, Suriani, Rungkat, Komansilan, & Wola, 2023). Based on the temporary findings of the researcher and an interview with one of the teachers at SMP Negeri 9 Manado, this junior high school is conducting online learning using online media in the form of Google Classroom, Google Meet, Zoom Meeting, Google Quitz and Google Form. Such conditions make students unable to directly see the problems that occur in nature.

In the field of education, ICT (Information and Communication Technology) plays a very important role in educating and educating the nation's life

(Wola, 2023). In addition, the development of ICT encourages the creation of creative innovations, such as the concept of electronic learning (e-learning) (Pavel, Fruth, & Neacsu, 2015). E-learning is a learning or teaching process that uses electronic circuits to deliver learning content, interaction or guidance (Elyas, 2018). E-learning is also a form of distance learning conducted through the Internet. This learning concept makes it easier for students and teachers to obtain learning resources with easy and light access. In order to teach students, especially critical thinking skills, creativity, collaboration and communication in learning, a teaching material media is needed in the form of an electronic module (e-module) (Rungkat, Jeujanan, Wola, & Warouw, 2023).

Water pollution in Lake Tondano is closely related to science subjects in junior high school about environmental pollution. The subject matter discusses the causes, impacts, and ways to overcome water pollution. The content presentation in online learning through online media can facilitate the learning and teaching process (Peimani & Kamalipour, 2021). This research aims to produce a science learning e-module with online media on water pollution matter in Lake Tondano that is feasible and effective.

Method

This type of research is research and development (R&D). The development model refers to Borg and Gall, modified by Palilingan (2014). The research steps include 1) planning, 2) exploratory study, 3) initial form development, 4) data collection and analysis instruments, 5) validation (expert validation and field testing), 6) revision based on validation results, and 7) socialization product (see Figure 1). The subjects of this study were a learning media expert, two subject matter experts, and ten seventh-grade students at SMP

Negeri 9 Manado. This research aims to develop a science learning e-module with online media on water pollution matter in Lake Tondano that is feasible and effective. The preparation activities until the product feasibility validation test were carried out from March to April 2021 at the Universitas Negeri Manado. On the other hand, a limited trial in the form of a small group student response trial was conducted in May 2021 at SMP Negeri 9 Manado.
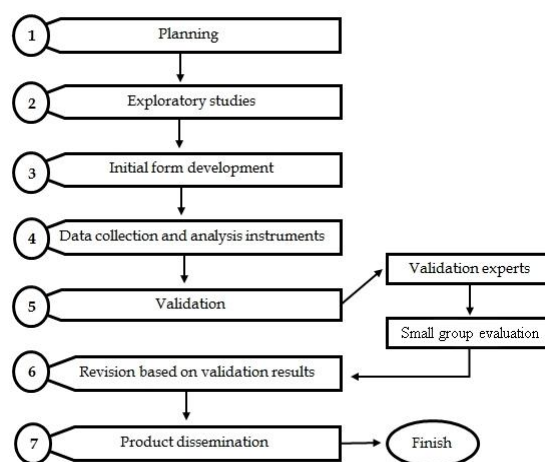

Figure 1. Research Flowchart

We use interviews, questionnaires, and test data collection techniques. Interviews are a data collection method in which an interviewer asks the respondents face-to-face, via telephone, or online (Moser & Korstjens, 2018). A questionnaire is a set of questions to gather data from respondents (Taherdoost, 2022). The instruments used in this study were interview sheets, product validation questionnaires, product practicality questionnaires, and learning outcomes tests. The questionnaire was used to assess the product feasibility. The validators filled out the validation questionnaire by giving an assessment referring to the score criteria of 4 (strongly agree), 3 (agree), 2 (less agree), and 1 (disagree).

After receiving an assessment from the validator, the value obtained is analyzed. After the results of expert validation, the e-module was tested on a

small group of 10 seventh-grade students at SMP Negeri 9 Manado. Equation 1 below is used to obtain validation proportion scores and student response trials.

$$P = \frac{\sum x}{\sum x_i} \times 100\% \qquad (1)$$

where P = percentage, ∑x = number of validator scores, and ∑x$_i$ = total ideal scores. After obtaining the proportion value, the next step is to interpret this value on the criteria for the level of validity and practicality, which can be seen in Table 1.

Table 1. Product Validity and Practicality Criteria

Intervals (%)	Criteria	
80 - 100	Very valid (No need to revise)	Very practical
60–79	Valid (Requires minor revision)	Practical
40–59	Less valid (Requires major revisions)	Less practical
0 – 39	Invalid (Not suitable for use)	Not practical

(Arikunto, 2014)

Based on Table 1, the developed product is deemed fit for use if it obtains a minimum percentage of 60%.

Results and Discussion

Learning and Product Planning

At this stage, planning is carried out to identify the learning objectives achieved and develop a science learning e-module with online media on water pollution matter in Lake Tondano using the Flip Pdf Corporate Edition application. Initial product embodiment stage, approval of learning experts and product publishers for testing.

Exploration Studies

Preliminary research or initial observations of the school where the research will occur. Surveying schools by interviewing subject teachers regarding learning and the media used to support learning amid the COVID-19 pandemic.

Early Form Development

The materials contained in this e-module come from undergraduate thesis research, printed books, the Internet, journals, and books. All materials are processed into MS Word to produce a science learning e-module with online media on water pollution matter in Lake Tondano. The creation of the science learning e-module framework and the use of the Flip Pdf Corporate Edition application to convert science learning modules into e-modules, namely the developed E-modules containing videos, audio and images.

Data Collection and Analysis Instruments

The instruments used in data collection are questionnaires and tests. Researchers use e-module material expert questionnaires, e-module media experts, and student respondent questionnaires. Meanwhile, the tests used are the initial (post-test) and the final (pre-test) questions. Data analysis using MS. Excel to calculate instrument data and learning outcomes obtained.

Validation by Media Expert

Based on the validation data of learning media experts, the total number of very suitable categories (SS) 19, suitable categories (S) 11, not suitable categories (TS) and very unsuitable categories (STS) did not exist. Based on the calculation, the percentage is 90.8%. The percentage is included in the valid category (no revision needed).

Validation by Material Expert

Based on the data of material expert 1 (Lecturer) and material expert 2 (Teacher), the total number of categories in material expert 1 is very suitable (SS) 24, appropriate category (S) 6, inappropriate category (TS) and very inappropriate category (STS) does not exist, while in material expert 2, it is very suitable (SS) 22,

the category is appropriate (S) 8, the category is not suitable (TS), and the category is not very suitable (STS) is not present. The data obtained above compares the number of values achieved with the maximum number of values then multiplied by 100%. Based on the calculation, the percentage of material expert test 1 is 95% and material expert 2 is 93.3%. The percentage is included in the valid category (no revision is needed).

Student Response Validation

Based on student response data, it was obtained that the total category was very suitable (SS) 87.6%, suitable category (S) 33%, not suitable category (TS) 55% and very unsuitable category (STS) 85.2%. Thus, students positively responded to the e-module of science learning about Lake Tondano water pollution that was given. There were no changes to be revised in revision phase 2, so the trial could be continued to the field trial stage.

Small Group Test

Based on small group test data, it can be obtained that all respondents 1-5 gave varied responses to 30 indicators of eligibility criteria for content, language, and usefulness of graphics with categories at very suitable (SS) 71.33%, appropriate category (S) 64.5%, the unsuitable category (TS) and the very unsuitable category (STS) did not exist. From the calculation above, the percentage included in the category is quite valid / does not need revision.

Student Learning Outcomes

Table 2. Summary of Pre-test and Post-test Result Data

No.	Statistics	Statistic Value	
		Pre-test	Post-test
1.	Minimum Score	20	50
2.	Maximum Score	85	95
3.	Sum ($\sum$)	1810	2305
4.	Mean ($\bar{x}$)	60,3	76,8
5.	Completeness percentage	23.3%	76.7%

The results of the learning outcomes test on 30 students with the KKM determined by the school was 75. Based on Table 2, it can be seen that the average analysis of the pre-test test results was 60.3 learning outcomes, with completeness reaching 23.3%. In comparison, the analysis of the average results post-test test is 76.8 learning outcomes with completeness reaching 76.7%. The learning device effectively meets the qualifications because it has high/very effective criteria.

Revision Based on Validation Results

After going through the product development and testing stages with students, this science learning module teaching material product has been revised or improved. The results of developing a science learning e-module with online media on water pollution matter in Lake Tondano can be accessed at https://s.id/BU87c. This link may be shared via online media with the following display:

Figure 2. E-Module Display on Laptop

Figure 3. Display of E-Modules on Smartphones

Figure 4. Display of E-Modules on iPad

Conclusion

This research succeeded in developing a science learning e-module with online media on water pollution matter in Lake Tondano that is feasible and effective to use. It can be seen from the results of expert assessments of learning media, subject matter, and small group tests to determine the product's practicality and student learning outcomes. The validity test by learning media experts obtained a score of 94%, categorized as very valid (no need for revision), and the validity test by material experts showed a score of 91%, categorized as very valid (no need for revision). Limited trials in small groups showed a score of 88% categorized as very practical. The average score of student learning outcomes of 77% categorized as effective. Based on the research that has been conducted, the science e-module with online media on water pollution material in Lake Tondano is declared feasible and effective for students to use.

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