Developing an interactive e-module for digestive system materials to improve the analysis ability of high school students

Melati Astria Jayanti* and Heru Nurcahyo
Universitas Negeri Yogyakarta
*Email: melatiastria.2020@student.uny.ac.id1

Abstract: This study aimed to develop an interactive e-module on digestive system materials for high school students in class XI at Senior High School 1 Cangkringan; determine the feasibility of the e-module based on the validation of expert lecturers, teachers, colleagues, and students; and determine the effectiveness of the e-module to improve students' analytical skills. The method used in this research was a *quasi-experimental one-group pretest-posttest design*. The research samples employed 11 students of class XI IPA at Senior High School 1 Cangkringan. The results of the study are as follows: the e-module had been developed based on the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation); the feasibility of the interactive e-module was in a good category, the effectiveness of the interactive e-module on the human digestive system material effectively increased students' analytical skills with an N-Gain Score of 0.48. Thus, it can be concluded that the interactive e-module is effective in improving students' analytical skills on the digestive system material within the moderate category.

Keywords: *interactive e-module, analytical skills, digestive system*

INTRODUCTION

The 2013 curriculum, which refers to the Minister of Education and Culture of the Republic of Indonesia Number 37 of 2018, contains Core Competencies (KI) and Basic Competencies (KD) for basic and secondary education. Since the 2013 curriculum is competency-based or standards-based, students are required to master a number of competencies that have been defined in the curriculum. The competency demanded is adjusted based on the level of education. In addition, the 2013 curriculum focuses on achieving a balance between *hard skills* and *soft skills* (Kemendikbud, 2013). That is to say, the students are required to have *Higher Order Thinking skills* contained in the 2013 Curriculum. The ability to think analytically is one part of the *Higher Order Thinking skills* (Sartono, Rusdi, & Handayani, 2018).

Most basic competencies in Biology requires students to master analytical skills. Therefore, one of the important competencies that should be mastered by students is analytical ability. Based on the results of observations, it showed that when students were assigned to analyze cases given by the teacher, students did not optimally use their analytical skills. It can be said that the students did not reach the target mastery level of of analytical skills. Hence, this study is intended to improve students' analytical skills regarding digestive system material.

The material used in this research was the human digestive system in class XI of Senior High School. Based on the research by Permana, Zulhijatiningsih, and Kurniasih (2021), it is

necessary to prepare teaching materials that support online learning, one of which is the use of electronic models or e-modules. This is a development research with referring design to the ADDIE (Analyze, Design, Development, Implementation, and Evaluationit was stated that the digestive system material was one of the difficult materials for the students. In line with this, the results of the national exam on the digestive system material in 2017-2019 revealed that the students at Senior High School 1 Cangkringan obtained 50.00 correct answers; 40.91; and 47.37% with absorption less than 55.00. Based on the results of the exam, the material that the students had not yet mastered was related to the digestive system specifically the digestive system process, nutrient content, as well as disorders and diseases in the digestive system. In addition, Aydin (2016) explained that there were still many students who had difficulty explaining the functions of the organs in the digestive system.

Analytical ability is a student's basic ability to think critically and is one of the higher cognitive abilities or *Higher Order Thinking skills (HOTs)* that is important for the students to master. The ability to think at a higher level is one of the achieved goals of education in the 21st century (Nawawi, Oviyanti, & Faizah, 2017). Prawita, Prayitno, and Sugiyarto (2019) states that the ability to think analytically is the capacity to identify, connect, and conclude based on the interconnection between statements, questions, concepts, descriptions or other forms that represent the expression of beliefs, reasons, information, and opinions needed to face the challenges of the 21st century.
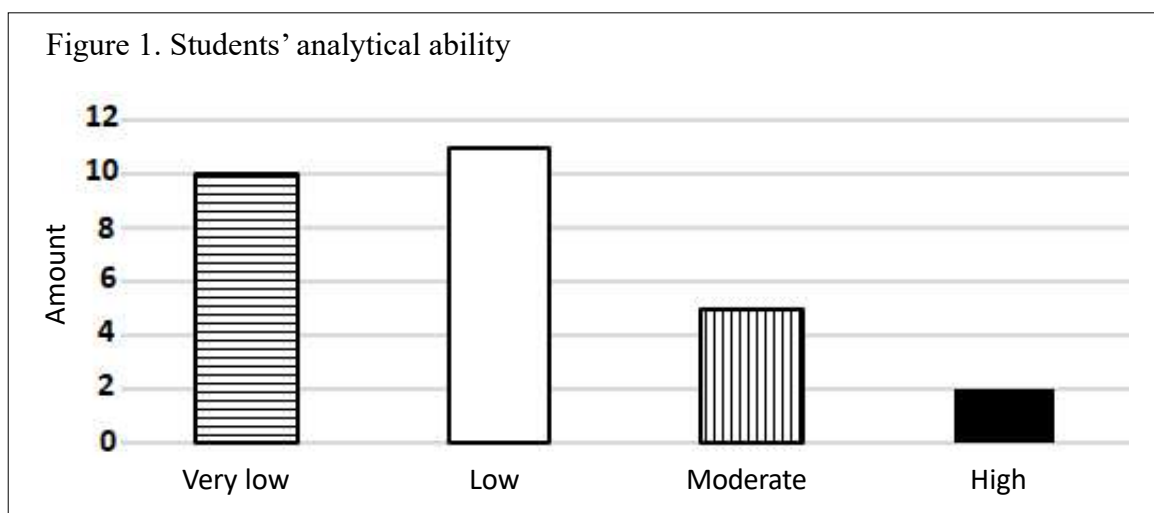
According to Facione (2011), analytical thinking skills were specifically divided into four indicators: interpreting information and ideas; identifying similarities and differences in reality and information presented; drawing hypotheses; and elaborating correlations between sentences or parts of a concept to draw conclusions. Research conducted by Eldes (2013) defined that it was possible to improve analytical thinking skills by using a model that appropriately matched the material characteristics and students' characteristics. Based on several studies, the ability to think analytically could be trained through learning models and the development of teaching materials. Tiantong Diraksa and Phairoth Terntachhatipong (2009) also found that learning was an activity that developed analytical thinking skills and models based on constructivist theory causing students to be motivated in carrying out activities. According to Dafrita (2017), he stated that analytical thinking skills can be developed using discovery learning.

However, research conducted by Prawita *et al.* (2019) showed that students' analytical thinking skills in Indonesia were still low. The indicator of interpreting information and ideas was 36%, identifying similarities and differences from reality from the information presented was 36%, developing hypotheses was 17%, and describing the relationship of sentences or parts of a concept to make decisions was 20%. This fact showed that students' analytical thinking skills were still low so that they needed to be improved.

In this study, indicators of analytical ability refer to the concept proposed by Anderson and Krathwohl (in Subali, 2019). It was stated that analytical ability was divided into three aspects, namely differentiating by being able to distinguish relevant and irrelevant things, organizing by being able to organize information obtained from various sources, and attributing by being able to interconnect theories and issues. Preliminary research had been carried out using these three indicators of analytical ability (Astriani, Susilo, Suwono, & Lukiati, 2018).

In the preliminary research on the profile of students' analytical abilities at Senior High School 1 Cangkringan, it was identified that their analytical skill was classified as low.

Figure 1 showed a graph of the analytical ability profile of students at Senior High School 1 Cangkringan.

Figure 1. Students' analytical ability

The results of the preliminary research on the profile of students' analytical abilities were classified in the low category. Moreover, based on the results of the needs analysis, it was considered necessary to develop teaching materials. Hence, this research provides an alternative solution in the form of e-module. This research is intended to develop e-module to improve students' analytical skills. Permana (2021)it is necessary to prepare teaching materials that support online learning, one of which is the use of electronic models or e-modules. This is a development research with referring design to the ADDIE (Analyze, Design, Development, Implementation, and Evaluation stated that the e-module should be interesting and able to motivate students in fostering their curiosity. In addition, e-module should be able to help teachers transfer information within the learning process (Hidayah, Dewi, & Retnoningsih, 2014). As one of the practical learning activities, carrying out e-module for student-centered learning can be one advantageous alternative in promoting students' analytical ability. Interactive e-module is considered as one significant solution that can be accomplished by systematically compiling the teaching materials.

Based on the stated problems, the resolution selected to elucidate the issues so that the students may improve their analytical skills is by developing teaching materials in the form of e-module. E-module is defined as teaching materials packaged digitally. E-module is likely able to help teachers facilitate students in the learning process (Dewi, 2020). Furthermore, E-module is pictured as digital learning medium that is systematically arranged so that students are able to solve the existing issues and learn independently (Diantari, 2018; Udayana, 2017).

Previous research related to the implementation of e-module found that the application of problem - based learning e-module may improve analytical thinking skills and reduce misconceptions in class X MIA 1 Senior High School 1 Banyudono within the academic year 2014/2015 regarding ecosystem material (Furqan, 2017). The results of this study obtained an increase in students' analytical abilities by 32% while a decrease in students' misconceptions by 40%. Permana's research (2021) stated that the results of limited and

wide scale trials show very good interpretations based on students' responses. The average N-Gain score was 0.57 so that it was categorized as moderate.

The present study employed the learning model of *discovery learning* intended to develop students' analytical skills. Hence, this study aimed to develop teaching materials in the form of interactive e-module on digestive system material that was expected to improve students' analytical thinking skills.

METHOD

The research was carried out in October-November 2021. This research was considered as a development research using the ADDIE model consisting of *Analyze, Design, Develop, Implement,* and *Evaluate* (Branch, 2010). The subjects of this study consisted of students from Senior High School 1 Cangkringan class XI MIPA in Odd Semester within Academic Year 2021/2022. The steps in the research and development process were adapted from the ADDIE model as seen in Figure 2.

The first stage was the analysis stage. The need analysis consisted of: analysis on infrastructure both owned by schools and students; analysis of gaps between the demands of the curriculum used and the competencies possessed; analysis on learning media usage by teachers; analysis on the need for the development; analysis on the need to formulate and identify learning objectives based on materials, core competencies, basic competencies, and indicators; analysis on the need to identify student characteristics such as whether the students had gadgets, whether the students were fluent and had no problems in operating the gadgets, whether the students had any problems with internet availability, and whether the students had any competencies needed to think analytically; and analyzing the need to develop curriculum based on educational level, basic competencies, and demands of the 21st century.
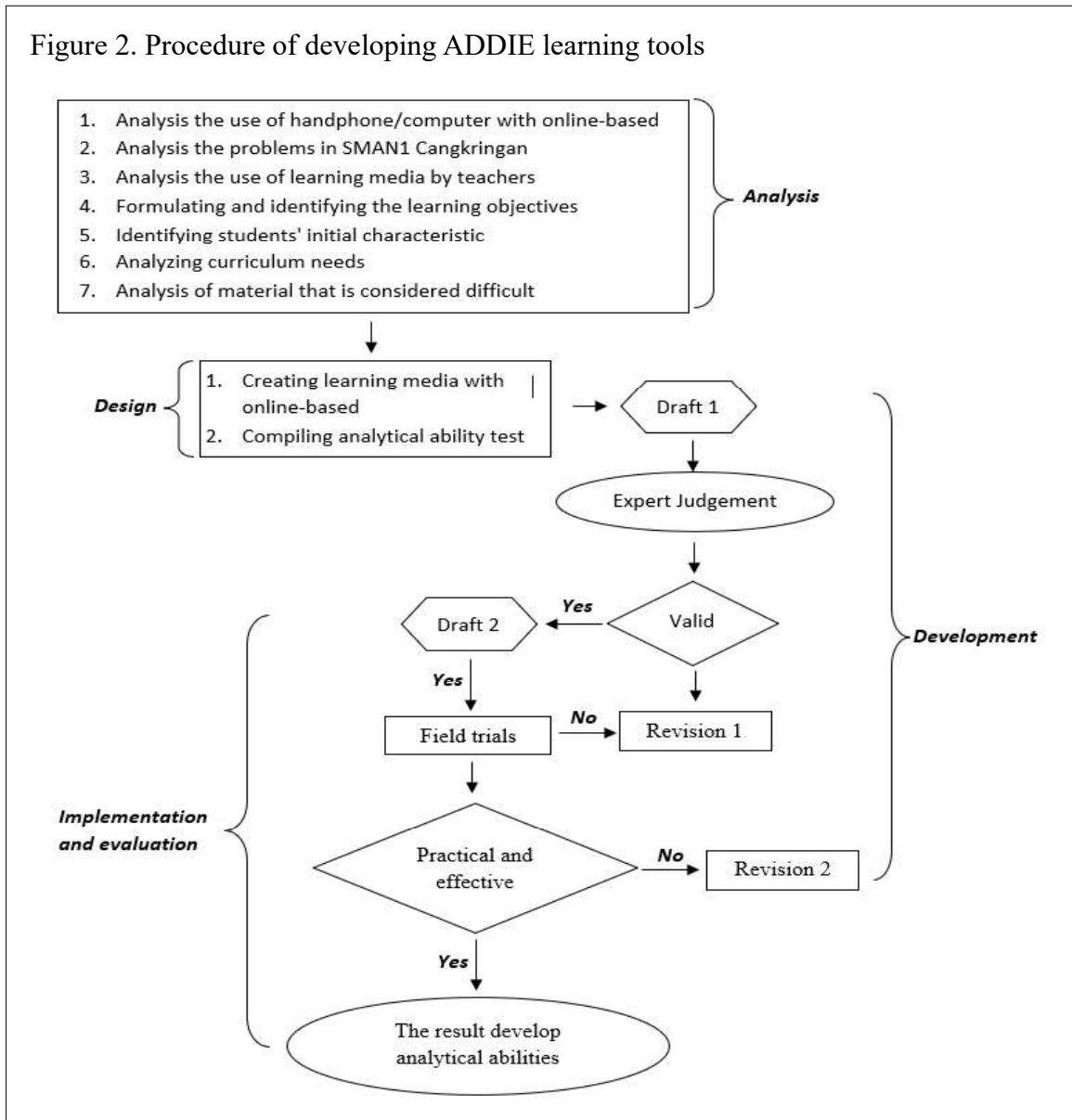
The second stage was the design stage or the planning stage. The resources preparation needed in the development of e-module consisted of curriculum sources, materials, additional sources in the form of flip books, websites, Microsoft, videos, online quizzes, and articles.

The third stage was the development stage. The process of creating e-module products included making *story charts* and *story boards*. The next stage was validation by the expert lecturers, teachers, colleagues, and class XII students who had studied the digestive system at the previous level.

The limited trial was conducted employing the students of XII MIPA hypothetical population at Senior High School 1 Cangkringan. The sample were 4 students of class XII MIPA 1 who had studied the digestive system previously. Since the e-module needed suggestions for improvement and revision, the product revisions were carried out until the results were considered valid so that the e-module can be used in the implementation stage. The e-module feasibility assessment data obtained from the results of validation by material experts, media experts, biology teachers, colleagues, and student responses were in the form of qualitative data. The data were then converted into quantitative data with the guidelines presented in Table 1.

To find out the percentage of eligibility, the data were calculated using a score analysis technique shown in formula (1). The results of the eligibility percentage were then interpreted according to the criteria presented in Table 2.

$$Score(\%) = \frac{Obtained\ score}{Maximum\ score} x100\% \quad (1)$$

Figure 2. Procedure of developing ADDIE learning tools

1. Analysis the use of handphone/computer with online-based
2. Analysis the problems in SMAN1 Cangkringan
3. Analysis the use of learning media by teachers
4. Formulating and identifying the learning objectives
5. Identifying students' initial characteristic
6. Analyzing curriculum needs
7. Analysis of material that is considered difficult

Analysis

Design

1. Creating learning media with online-based
2. Compiling analytical ability test

Draft 1

Expert Judgement

Valid — Yes → Draft 2

Development

Draft 2 — Yes → Field trials — No → Revision 1

Valid → Revision 1

Implementation and evaluation

Practical and effective — No → Revision 2

Yes ↓

The result develop analytical abilities

Tabel 1
Conversion of e-module feasibility assessment results

Scale	Score
Strongly agree	4
Agree	3
Don't agree	2
Strongly Disagree	1

The fourth stage was the e-module implementation stage to determine the effectiveness of the e-module on students' analytical abilities. In the field trial, the samples used were 11 students of class XI MIPA 1 at Senior High School 1 Cangkringan using *purposive sampling*

Table 2
Percentage and media eligibility

Percentage(%)	Criteria
81<score≤100	Very good
61<score≤80	Good
41<score≤60	Enough
21<score≤40	Not good
0<score≤20	Not very good

(Sugiyono, 2015)

in a hypothetical population of class XI MIPA 1 at Senior High School 1 Cangkringan. The trial design used was *a quasi experiment* one group *pretest posttest design* presented in Table 3.

Table 3
Quasi experiment one group pretest posttest design

O_1	X	O_2

Details:

O_1 : Pretest Score (before the treatment)
X : Treatment using interactive e-module
O_2 : Posttest Score (after the treatment)

The pretest and posttest were used to determine the increase in students' scores before the treatment using interactive e-module and after the treatment using interactive e-module. Pretest and Posttest analysis using the N-Gain Score using formula (2) and the categories were stated in Table 4.

$$N\ Gain = \frac{Pretest\ Score - Posttest\ Score}{Ideal\ Score - Pretest\ Score} \quad (2)$$

Table 4
Distribution of gain scores

N-Gain Value	Category
g>0.7	High
0.3≤g≥0.7	Moderate
g≤0.3	Low

Source: Melzer in Syahfitri

The fifth stage, namely the evaluation stage, included a number of reflection on a series of steps carried out to improve the product so that it became the final product in the form of an interactive e-module on digestive system material to improve the students' analytical skills.

RESULTS AND DISCUSSION

The results and discussion in this study are based on the ADDIE development model. The first stage is the analysis stage. The following is the relationship between competence and material presented in Table 5.

Based on Table 5, there were nine topics that are mapped with competency analysis aspects of analytical ability. To achieve the basic competency number 4, the students were asked to carry out virtual practicum and calculate energy needs and balance.

In the second stage, namely the design stage, the e-module design was created which was then presented in the form of a concept map and story board (Table 6). The e-module framework was compiled into a unified whole in accordance with the requirements contained in the 2013 curriculum and presented in Figure 3.

The third stage was the development stage. The e-module development stage was the process of gathering information about the feasibility of the e-module and the accuracy of the e-module in developing students' analytical skills. This stage began with validation process by 2 experts, namely a lecturer and a biology teacher. After validating the interactive e-module by the two experts, a limited trial was carried out to assess the feasibility of the interactive e-module in class XII students who had studied the digestive system at the previous level (Figure 4).

The fourth stage was the implementation stage. After the revision process based on the validation results by the experts, the next stage was a field trial using *the one group pretest posttest technique.*
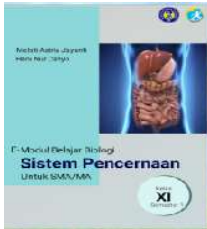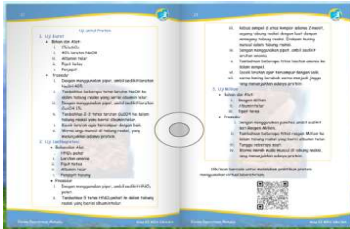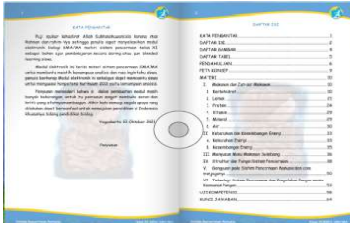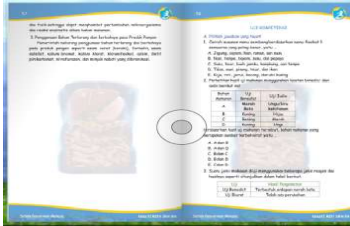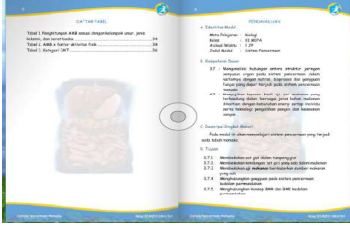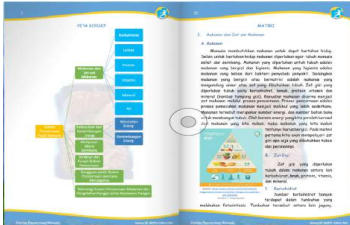
The implementation stage was carried out to measure the effectiveness of interactive e-modules on students. Table 7 displayed the *N-Gain data* of students' analytical abilities

Table 5

The relationship between competence and essential material in interactive e-module

Basic competencies	Subject	Material	Indicator
3.7 Analyzing the relationship between the structure of the organ-composing tissue in the digestive system in relation to nutrition, bioprocesses and functional disorders occurring in the human digestive system	Nutrition, BMI, BBI, AMB, disorders of the digestive system, technology for food and the digestive system	Digestive system	1. Differentiate the content of food substances using food tests 2. Differentiate the content of food substances using food tests 3. Differentiate the content of food substances with food tests 4. Interconnect disorders of the digestive system with food consumed based on BMI 5. Correlate weight and height with BMI
4.7. Presenting reports on the results of food substance tests contained in various types of food ingredients related to the energy needs of each individual as well as food processing technology and food safety			6. Interconnect the structure of the digestive organs with their proper function 7. Organize information about the digestion curve of nutrients 8. Organize information about nutrient deficiencies with digestive/body disorders 9. Organize the right types of food processing technology and food safety

Table 6
Story board

Picture	Details	Picture	Details
	E-module cover. There are function buttons, such as going to the next page and enlarging the page.		The food sub-stance test is carried out virtually. Directly scan the barcode / directly click on the barcode to carry out a virtual food substance test.
	- Foreword - List of contents. Users can directly click on the intended page in the table of contents.		Competency tests are used for evaluation along with the answer keys.
	Introduction. There are the title identity, basic competencies, a brief description of the material, objectives, and instructions for use.		The mnemonic and several videos contained in the e-module.
	Concept map and materials. The link in the form of a resource below the image can be clicked directly to go to the intended page.		On the glossary, there are a number of biological terms for digestive system material.

for each indicator. The average *N-Gain* obtained was 0.48 in the moderate category. The following was the *N-Gain Score* for each indicator of analytical ability.

The N-Gain Score results showed an increase in scores before the treatment of implementing interactive e-module and after the treatment of implementing interactive e-module. The effectiveness of the interactive e-module was in the moderate category. The result was in accordance with the prior research (Wulandari, Sudatha, & Simamora, 2020) stating that the application of interactive e-module affected students' learning outcomes. The higher the student's analytical ability, the more it will affect students' learning outcomes.

Product implementation in the form of teaching materials made in the form of e-module was carried out at Senior High School 1 Cangkringan. The research subjects needed biology teachers, class XII students, and class XI students with the following criteria. The Biology teachers should have the experience in teaching Biology, have the experience in teaching for more than 15 years, have the ability to use devices and operate e-module. Whereas for class XII students, they should be equipped with the criteria of having taken digestive system material

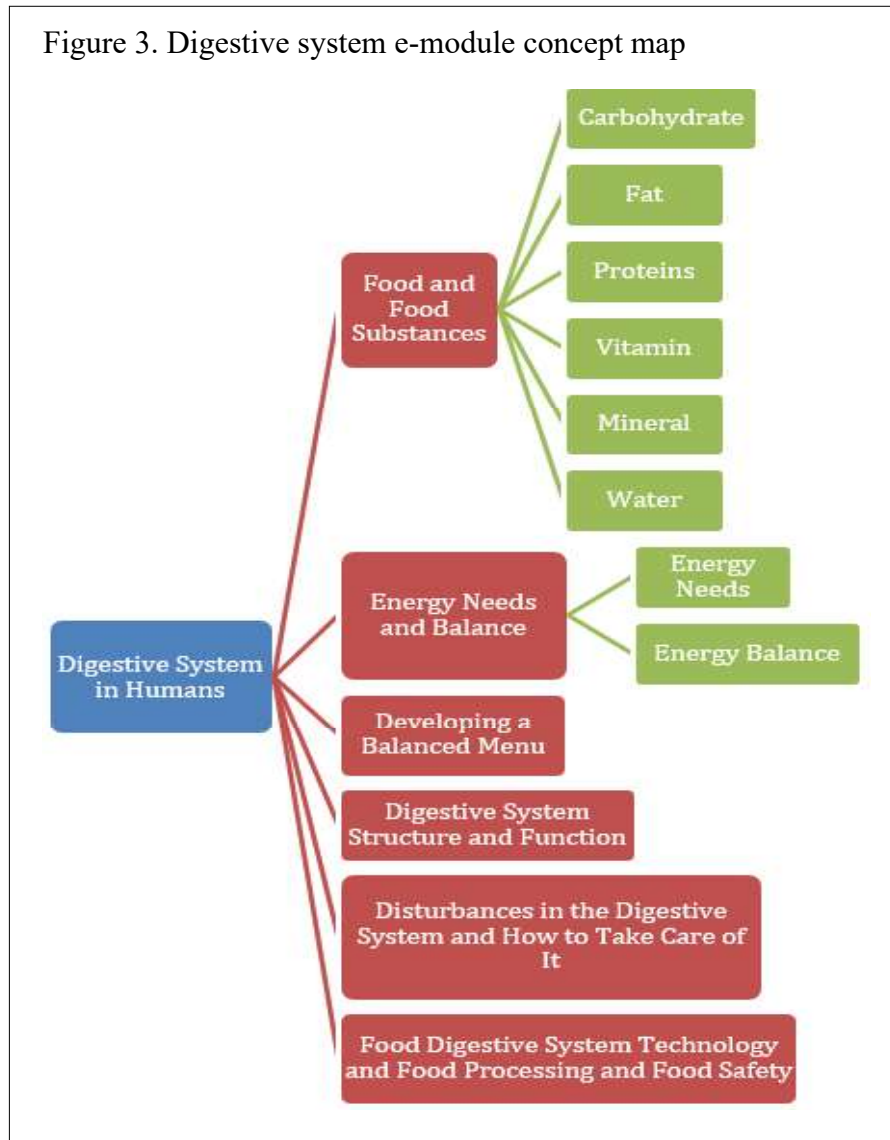Figure 3. Digestive system e-module concept map

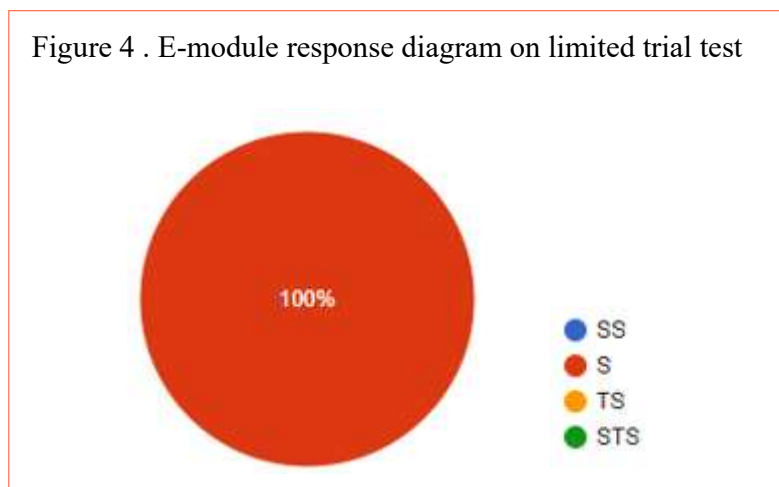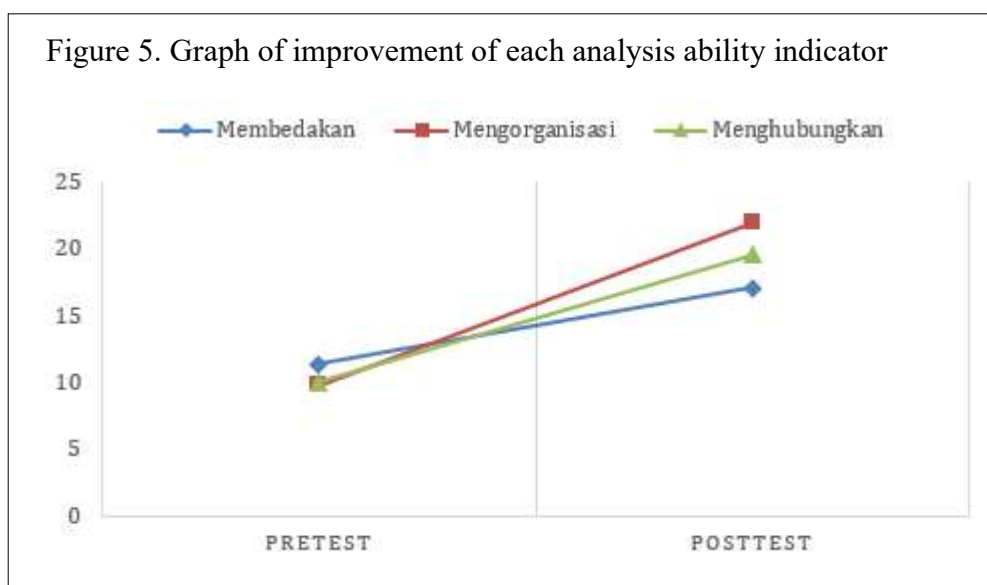Figure 4 . E-module response diagram on limited trial test

Table 7
Improvement of each indicator of analytical ability

No	Indicator	Pretest	Posttest	N-Gains	Category
1	Differentiating is able to distinguish things that are relevant and irrelevant	11.37	17.05	0.32	Moderate
2	Organizing is able to organize information obtained from various sources	9,83	21.91	0.60	Moderate
3	Attributing is able to connect the parts that exist in a theory into the issue	10	19.55	0.52	Moderate

Figure 5. Graph of improvement of each analysis ability indicator

at the previous level and having the ability to use devices and operate e-module on devices. Then class XI students should have the ability in using devices and operating e-module.

Product implementation in the form of interactive e-module teaching materials was carried out in two meetings. The first meeting was held on Tuesday, 23 November 2021 at 9.30-10.30 in class XI MIPA 1 with 11 students. The learning was carried out in a top-down attendance system and those who entered class on that day were students with lower numbers, namely numbers 19-36. Meanwhile, students who were at home (online learning) with higher numbers namely 1-18 were given an online *pretest*. At the first meeting, students were given a pretest to test their analytical skills before the treatment of implementing the interactive e-module.

The second meeting was held on Tuesday, 30 November 2021 at 9.30-10.30 in class XI MIPA 1. The learning process was carried out in a top-down presence system and those who entered class on that day were students with higher numbers, namely numbers 1-18. Meanwhile, students who were at home (online learning) with lower numbers namely 19-36 were given an online analysis ability test. At the second meeting, the students were given a posttest to measure students' analytical abilities after the treatment of implementing the interactive e-module.

In learning the digestive system material using the *discovery learning model,* the e-module was distributed in the middle of the meeting (third meeting) within the learning process. The reason for giving treatment in the form of an interactive e-module at the third meeting was because the interactive e-module was used for independent learning at home. Then, it was assumed that the students were able to repeat the topic of previous and latter materials of digestive system. Furthermore, if the students found difficulties in using the interactive e-module, they were able to ask the teachers at school or through *the Whatshap group (WAG).*

The teacher, then, provided an assessment related to the e-module. The assessment given by the teacher regarding indicators, tests, and the initial display of interactive e-module. Based on the analysis of students in the experimental class, the result obtained was 0.48 which means the effectiveness of using the e-module was in the moderate category. That is to say, the interactive e-module material regarding digestive system was considered effective in improving students' analytical skills. The result was in line with the research conducted by Sudarman and Ardian (2021) stating that interactive e-module is appropriate for use in learning. Therefore, the interactive e-module was able to effectively improve students' analytical skills (Nurhemy, Sutarno, & Prayitno, 2019).

The evaluation stage was carried out to analyze teaching material products in the form of interactive e-module that had been developed as supporting tools for learning biology suitable for use and effective in increasing students' analytical abilities. The basis for evaluating the feasibility of the product was analyzed based on data from the validation results of material experts, media, teachers, and limited trials. Meanwhile, the evaluation of the effectiveness of the product for increasing analytical skills was carried out based on the results of the implementation of teaching material products in the form of interactive e-module at the field trial stage. The product feasibility was in the good category while the product effectiveness was in the moderate category.

CONCLUSION

The conclusion from this research is that e-module has been developed based on the ADDIE development model *(Analysis, Design, Development, Implementation,* and *Evaluation).* The feasibility of interactive e-module is in the good category . The effectiveness of interactive e-module related to the human digestive system effectively improves students' analytical skills with the N-*Gain Score* of 0.48. Therefore, it can be concluded that the interactive e-module is effective in increasing students' analytical skills on digestive system material within the moderate category.

REFERENCES

Astriani, D., Susilo, H., Suwono, H., & Lukiati, B. (2018). Profil keterampilan berpikir analitis mahasiswa calon guru IPA dalam perkuliahan biologi umum. *Jurnal Penelitian Pendidikan IPA*, *2*(2). https://doi.org/10.26740/jppipa.v2n2.p66-70

Aydin, S. (2016). To what extent do Turkish high school students know about their body organs and organ systems? *International Journal of Human Sciences*, *13*(1). https://doi.org/10.14687/ijhs.v13i1.3498.

Branch, R. M. (2010). Instructional design: The ADDIE approach. In *Encyclopedia of Creativity, Invention, Innovation and Entrepreneurship*. https://doi.org/10.1007/978-3-319-15347-6_300893.

Dafrita, I. E. (2017). Pengaruh discovery learning terhadap kemampuan berpikir kritis dan analitis dalam menemukan konsep keanekaragaman tumbuhan. *Jurnal Pendidikan Informatika Dan Sains*, *6*(1), 32-46.

Dewi, A. K. (2020). *Hasil belajar kemampuan analisis dan sikap peduli lingkungan siswa pada pembelajaran materi perubahan lingkungan dengan pendekatan jelajah alam sekitar* (Skripsi tidak diterbitkan). FMIPA UNNES, Semarang.

Facione, P. A. (2011). Critical thinking: What it is and why it counts. *Insight assessment*, *1*(1), 1-23.

Furqan, M., Karyanto, P., & Salma, S. (2017). Penerapan e-module berbasis problem based learning untuk meningkatkan kemampuan berpikir analitis dan menurunkan miskonsepsi siswa kelas X MIA 1 SMA Negeri 1 Banyudono. *Prosiding Seminar Nasional XII*, *12*(1), 410-414.

Hidayah, W., Dewi, N. K., & Retnoningsih, A. (2014). Pengembangan komik pencemara lingkunan sebagai sumber belajar siswa kelas VII SMP. *Journal of Biology Education*, *3*(3), 319-329. https://doi.org/10.15294/jbe.v3i3.4532.

Nawawi, S., Oviyanti, F., & Faizah, U. (2017). Pengaruh model generative learning terhadap kemampuan analisis siswa pada materi sistem saraf manusia. *Edubiotik: Jurnal Pendidikan, Biologi Dan Terapan*, *2*(02), 30-39. https://doi.org/10.33503/ebio. v2i02.130.

Nurhemy, T., Sutarno, S., & Prayitno, B. (2019). Efektivitas modul berbasis problem solving untuk meningkatkan kemampuan analisis siswa. *INKUIRI: Jurnal Pendidikan IPA*, *8*(2), 137-143. https://doi.org/10.20961/inkuiri.v8i2.37751.

Permana, I., Zulhijatiningsih, Z., & Kurniasih, S. (2021). Efektivitas e-modul sistem pencernaan berbasis problem solving terhadap kemampuan pemecahan masalah. *Jurnal IPA & Pembelajaran IPA*, *5*(1), 36-47. https://doi.org/10.24815/jipi.v5i1.18372.

Prawita, W., Prayitno, B. A., & Sugiyarto. (2019). Effectiveness of a generative learning-based biology module to improve the analytical thinking skills of the students with high and low reading motivation. *International Journal of Instruction*, *12*(1), 1459-1476. https://doi.org/10.29333/iji.2019.12193a.

Sartono, N., Rusdi, R., & Handayani, R. (2018). Pengaruh pembelajaran process oriented guided inquiry learning (pogil) dan discovery learning terhadap kemampuan berpikir analisis siswa SMAN 27 Jakarta pada materi sistem imun. *Biosfer: Jurnal Pendidikan Biologi*, *10*(1), 58-64. https://doi.org/10.21009/biosferjpb.10-1.8.

Sudarman, S., & Ardian, A. (2021). The development of interactive module to support student centered learning. *Akademika: Jurnal Teknologi Pendidikan*, *10*(01), 77-92.

Wulandari, I. G. A. A. M., Sudatha, I. G. W., & Simamora, A. H. (2020). Pengembangan pembelajaran blended pada mata kuliah Ahara Yoga Semester II di IHDN Denpasar. *Jurnal Edutech Undiksha*, *8*(1), 1. https://doi.org/10.23887/jeu.v8i1.26459.