# DIGESTIVE SYSTEM E-MODULE BASED ON INTEGRATED-STEM IN STUDENT'S SCIENCE LITERACY AND LEARNING OUTCOME

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***Abstract***

*This article dicussses how the digestive system e-module based on integrated STEM is used to improve student'sscientific literacy and learning outcome. Scientific literacy is a person's ability to understand science, communicate science, and apply scientific knowledge to solve problems so that they have a high attitude and sensitivity to themselves and their environment in making decisions based on scientific considerations. This research is a development research). The method used is development model suggested by Borg and Gall (1989) in Sugiyono (2015). The research stages are, 1) Potential Problems; 2) Data Collection, 3) Product Design, 4) Product Review; 5) Design Revision; 6) Design Validation; 7) Product trial; 8) Product Revision; 9) Mass Product Manufacturing. The result of pre-research question given to students, it is known that from 37 students 34 of them have low or incomplete scientific literacy scores. So that 91.8% of students have a low level of scientific literacy and 8.1% of students have a good level of scientific literacy. The scientific literacy domain which has the lowest score is science attitude and the final product of the learning using e-module is gerd candy made by students. The developed of e-module is based on a STEM approach consisting of four aspects, namely: (1) Science; (2) Technology; (3) Engineering; and (4) Mathematics. This module is developed to increase students' scientific literacy for four domains, namely: (1) the context of science; (2) Science knowledge; (3) Science competence; and (4) scientific attitude.*

***Keywords:*** *E-module, Integrated-STEM, Scientific literacy*

## 1. INTRODUCTION

Natural Sciences is a subject that considered to be complicated by students. One of the science subjects in high school is Biology. The low student learning outcomes in the subject of Biology become one of indicator for the low interest of students in learning science. Based on Permendikbud No. 23 of 2016 concerning Educational Assessment Standards for students is expected to exceed the minimum completeness score. However, this is not in line with the facts on the school. Based on the average national exam data by the Ministry of Education and Culture in 2019, it is known that Biology subjects scored low in the National Examination. At the high school level the average student's national exam in Biology is 50.61 and at the MA level is 47.36 in the range of 1-100 points (Kemdikbud, 2019).

Based on the Guide to Implementing 21st Century Skills, the 2013 Curriculum states that 21st Century learning is learning that integrates literacy skills, knowledge skills, skills and attitudes, and mastery of technology, so that the urgency of scientific literacy as part of 21st century skills is seen as important. Currently, educating the public to have scientific literacy is the main goal in any science education reform (Pratiwi, 2019).

Scientific literacy is a person's ability to understand science, communicate science, and apply scientific knowledge to solve problems so that they have a high attitude and sensitivity to themselves and their environment in making decisions based on scientific considerations (Toharudin, 2011). Indonesia is one of the participating countries that join in the literacy study conducted by PISA. Indonesia is ranked 72 out of 77 participating countries. The average score of Indonesian scientific literacy based on the results of the PISA study from 2006 to 2018 shows the average scientific literacy of Indonesian students at 391 with the average score of other countries still above 500. The scores are from 2006, 2009, 2012, 2012, 2015, and 2018 respectively at 393, 383, 382, 403, and 396 (OECD, 2019). Based on this description, it is known that the average scientific literacy value of Indonesian students is still far below the average.

According to Dwiningsih (2018), the current global generation is very sensitive to

technology, meaning that they have the advantage of being able to use technology to develop knowledge. This great potential should be utilized optimally by teachers to develop technology-based teaching materials. So, the urgency of developing the latest technology-based modules that can improve scientific literacy and student learning outcomes is very important.

One approach that can improve students' scientific literacy is the integrated-STEM. According to Listiana (2019) STEM provides an opportunity for teachers to demonstrate to students concepts, principles, science, technology, engineering, and mathematics that are integrated into the development of products, processes, and systems used in solving real-life problems. Futhermore, scientific literacy ability is closely related to technological and mathematical literacy where scientific ability is strongly influenced by systematic, logical and rational thinking, which has the potential to be trained in mathematics (Permatasari, 2016). The urgency of developing integrated STEM-based e-modules is important to improve scientific literacy and student learning outcomes.

## 2. RESEARCH METHODS

This type of research is development research). Research and development was a method used to research so as to produce new products, and then test the feasibility of these products. This study refers to the device development model suggested by Borg and Gall (1989) in Sugiyono (2015). The research stages are, 1) Potential Problems; 2) Data Collection, 3) Product Design, 4) Product Review; 5) Design Revision; 6) Design Validation; 7) Product trial; *8)* Product Revision; 9) Mass Product Manufacturing.

Primary data sources of this research were the students in the 11th grade of high school 1 Krian totaling 37 respondents. This research was obtained by giving the students test that consisted of two components. First, the test consisted of question to measure students' learning outcome. The second, the test consist of question to measure students' science literacy based on its domain which are science context, science knowledge, science competence, and science attitude.

Table 1. Pre-Research Question Results

| Nu. | Name | Learning outcome score | Science literacy score | | | Final score |
|---|---|---|---|---|---|---|
| | | | Science Knowledge | Science Competence | Science Attitude | |
| **1** | FRM | 20 | 20 | 10 | 0 | 50 |
| **2** | AES | 30 | 20 | 10 | 0 | 60 |
| **3** | AM | 40 | 20 | 10 | 0 | 70 |
| **4** | DNA | 50 | 0 | 0 | 0 | 50 |
| **5** | IMM | 50 | 10 | 10 | 0 | 70 |
| **6** | ASA | 50 | 10 | 10 | 0 | 70 |
| **7** | ERA | 50 | 10 | 10 | 0 | 70 |
| **8** | DJS | 50 | 10 | 10 | 0 | 70 |
| **9** | LO | 50 | 20 | 10 | 0 | 80 |
| **10** | ASD | 40 | 0 | 10 | 0 | 50 |
| **11** | ACAM | 50 | 0 | 10 | 0 | 60 |
| **12** | MVSP | 40 | 10 | 10 | 0 | 60 |
| **13** | ANA | 40 | 0 | 10 | 0 | 50 |
| **14** | AWP | 40 | 10 | 10 | 0 | 60 |
| **15** | SNF | 50 | 10 | 10 | 0 | 70 |
| **16** | MAA | 50 | 0 | 10 | 0 | 60 |
| **17** | RWAW | 30 | 0 | 10 | 0 | 40 |
| **18** | DAG | 20 | 0 | 10 | 0 | 30 |
| **19** | SAY | 10 | 0 | 0 | 0 | 10 |
| **20** | SA | 10 | 10 | 10 | 0 | 30 |

| Nu. | Name | Learning outcome score | Science literacy score | | | Final score |
|---|---|---|---|---|---|---|
| | | | Science Knowledge | Science Competence | Science Attitude | |
| **21** | EDA | 40 | 0 | 10 | 0 | 50 |
| **22** | RSH | 30 | 0 | 0 | 10 | 40 |
| **23** | DRP | 20 | 0 | 0 | 0 | 20 |
| **24** | HRKN | 50 | 0 | 10 | 0 | 60 |
| **25** | TSP | 10 | 10 | 10 | 0 | 30 |
| **26** | NSI | 10 | 10 | 10 | 0 | 10 |
| **27** | SFR | 40 | 10 | 10 | 0 | 60 |
| **28** | SKNA | 40 | 10 | 10 | 0 | 60 |
| **29** | ABM | 50 | 20 | 10 | 0 | 80 |
| **30** | RSM | 30 | 10 | 10 | 10 | 60 |
| **31** | RH | 50 | 0 | 10 | 0 | 60 |
| **32** | RDR | 40 | 0 | 10 | 10 | 60 |
| **33** | NES | 30 | 0 | 0 | 0 | 30 |
| **34** | BY | 50 | 0 | 10 | 0 | 60 |
| **35** | MALP | 10 | 0 | 0 | 0 | 10 |
| **36** | SA | 10 | 10 | 10 | 0 | 30 |
| **37** | FRM | 0 | 10 | 10 | 0 | 20 |

## 3. RESULT AND DISCUSSION

a) Results of Pre-Research Questions

The results of pre-research question that have been filled by 37 students shown in the following table. At this stage, pre-research data was collected at high school 1 Krian. Data collection was obtained by distributing needs analysis questionnaires for teachers and students as well as scientific literacy questions. The needs analysis of the student questionnaires provided included (1) The commonly used learning models or methods; (2) The way students learn in understanding the material; (3) Students' opinions regarding the material of the human digestive system in Biology learning; and (4) the level of scientific literacy of students in general. As for the needs analysis, the teacher's questionnaire provided includes (1) The commonly used learning models or methods; (2) The material characteristics of the human digestive system; and (3) STEM-based learning and scientific literacy.

The questions to test students' scientific literacy contain four domains, namely: (1) the context of science includes personal, local/national, and global issues; (2) Science knowledge includes content, procedural, and epistemic; (3) Science competence includes explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and facts scientifically; (4) The attitude of science includes assessing the scientific approach to investigation and the attitude of caring for the environment.

Based on the teacher needs analysis questionnaire, it is known that according to the teachers as many as 68.75% of students feel quite interested and 21.87% are very interested in learning Biology. A total of 56.25% of students scored more than the minimum completeness score and 15.62% of students had the same score as the minimum completeness score. As many as 56.25% of teachers stated that the obstacles in learning science were limited in the learning media available. As many as 40.62% of teachers use textbooks during the learning process in class, 40.62% of them use work sheet, and 9.37% use paper modules. As many as 71.87% of teachers stated that they had never used electronic modules or e-modules as learning media. Meanwhile, learning that is considered suitable is learning with a variety of methods and practicum, appropriate learning media, and connected with everyday phenomena. As many as 81.25% of teachers stated that they had never used certain learning methods to improve students' 21st century skills, 75% of teachers did not know about scientific literacy, and 71.42% had never applied the STEM approach

during learning. Overall, they stated that they knew about scientific literacy and STEM but did not understand in more detail about both.

Furthermore, based on the results of the student needs analysis questionnaire, it was found that 74% of students stated that they were quite interested in learning science, 51.8% of students stated that the learning material was quite difficult and 40.7% of them stated that the learning they had done so far was boring. A total of 44.4% of students stated that the learning was based on classroom learning. The learning that never has the ultimate goal in making a problem-solving product. And 54.1% of them do rote to understand learning. This is supported by as many as 88.8% of students who stated that they had never done practicum related to the material of the digestive system. As for the scientific literacy aspect, as many as 92.5% of students stated that learning had been associated with everyday phenomena. However, 51.8% of students stated that they could not design a simple practicum related to the material of the human digestive system.

Meanwhile, based on scientific literacy questions distributed to students in Table 1, it is known that from 37 students 34 of them have low or incomplete scientific literacy scores. So that 91.8% of students have a low level of scientific literacy and 8.2% of students have a good level of scientific literacy. These results indicate that the level of scientific literacy of students is still very low. The scientific literacy domain which has the lowest score is science attitude. So, from the result science attitude can be explained by the interest in science and technology, value science by conducting investigations when needed, and perception and awareness of environmental issues. The data shown in the table 1, can be summarized in Figure 1.

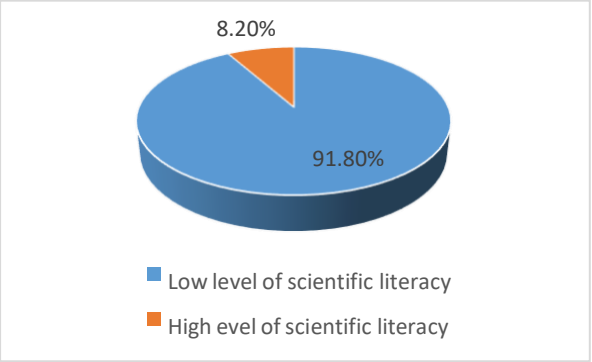


**Figure 1.** Percentage of student's scientific literacy level

b) Results of Developing E-module Based Integrated-STEM

This research has final result to develop a STEM-based e-module to improve scientific literacy and student learning outcomes on the material of the human digestive system. The design of the e-module can be described through the following stages:

a. Determine the learning objectives to be achieved.

The first step is to formulate student learning indicators to determine learning objectives. The formulation of indicators is based on basic competencies in accordance with the revised 2013 curriculum. The indicators of competency achievement and learning objectives formulated can be seen in table 2.

**Table 2. Basic Competence, Competency Achievement Indicator, and Learning Objectives**

| Basic Competence | Competency Achievement Indicator | Learning Objectives |
|---|---|---|
| 3.7 Analyzing the relationship between the structure of the tissues that make up the organs in the digestive system in relation to nutrition, bioprocesses and functional disorders that can occur in the human digestive system | 3.7.1 Analyzing the relationship between the tissue structure of the digestive organs in relation to nutrition and bioprocess | 3.7.1.1 Learners can analyze the relationship between the structure of the tissues making up the digestive organs in relation to nutrition and bioprocesses through an appropriate learning video. |

| Basic Competence | Competency Achievement Indicator | Learning Objectives |
|---|---|---|
| | 3.7.2 Analyzing disorders of the function of the human digestive system | 3.7.2.1 Learners can analyze disorders of the function of the human digestive system that can occur through articles presented appropriately |
| 4.7 Presenting a report on the test results of food substances contained in various types of food ingredients related to the energy needs of each individual as well as food processing technology and food safety | 4.7.1 Presenting test results on food substance test results on a food processing technology | 4.7.1.1 Students can present the results of a food substance test on a food processing technology through a simple experiment |

b. Material collection

At this stage is to collect the material used in the e-module based on relevant sources. The learning material that will be developed into the e-module is the human digestive system material. In this study, the materials used in the human digestive system include food substances, the structure and function of the digestive system, and digestive system disorders in humans.

c. Elements arrangement

The developed e-module is based on a STEM approach consisting of four aspects, namely: (1) Science; (2) Technology; (3) Engineering; and (4) Mathematics. Meanwhile, the scientific literacy in the developed e-Module covers four domains, namely: (1) the context of science; (2) Science knowledge; (3) Science competence; and (4) scientific attitude. The e-module design developed is summarized in table 3.

**Table 3.** Digestive System e-module based integrated-STEM design

| Nu | E-module Component | Design Content |
|---|---|---|
| **1** | Preface | Foreword<br>Table of contents<br>About STEM<br>About Scientific Literacy |
| **2** | Introduction | Main and Basic Competence<br>Learning objectives<br>Module Usage Instructions<br>Module Components<br>Concept maps |
| **3** | Learning Component | **STEM Aspects in Module:**<br>a) Chapter 1. Nutrients and their Functions<br>***1) Science :***<br>1) Article corner. Carbohydrate diet good or not ?<br>2) Learning Activities 1. Analyzing Food Substances<br>***2) Mathematic :***<br>- Calculate BMR using Harris-Benedict<br>- Learning Activities 2. Calculate BMR<br>***3) Technology :***<br>- Carbohydrat Processing Technology |

| Nu | E-module Component | Design Content |
|---|---|---|
| | | b) Chapter 2. Structure and Function of the Digestive System<br>***1) Science :***<br>- *About science* and Science TV about Cholesterol<br>***2) Mathematic :***<br>- Cholesterol levels in the blood<br>***3) Technology :***<br>- Cholesterol measuring device<br>c) Chapter 3. Disorder of the Digestive System<br>***1) Science :***<br>- Article Corner. Antacids<br>- Work Sheet 1.<br>✓ Article Corner. The danger of GERD<br>✓ Study Task 1. The important point of article corner<br>***2) Technology :***<br>- Gastric Endoscopy<br>***3) Engineering :***<br>- Work Sheet 1.<br>Study Task 4. Documenting the experiments carried out<br>✓ Article with the title "Chew mint to reduce stomach acid"<br>✓ Study Task 2. Presenting ideas for herbal plants as ulcer medicine<br>✓ Learning Task 3. Designing an experiment for making gastric candy<br>✓ Study Task 4. Documentating the experiments done<br>- Work Sheet 2.<br>✓ Testing the final product (gerd candy) made by students |
| | | **Material Supporting Components in the Module :**<br>a) Chapter 1. Nutrients and their Functions<br>1) Nutrients Concept Map<br>2) Macro Nutrients<br>- Carbohydrate<br>- Fat<br>- Protein<br>3) Micro Nutrients<br>- Vitamin<br>- Minerals<br>4) Food Substance Test<br>- Learning Activities 3. Nutrient Test<br>- Learning Activities 4. Case study of nutrients test<br>b) Chapter 2. Structure and Function of Digestive System<br>1) Intoduction<br>- Science TV : the journey of foof in the digestive system<br>- Learning activities 5. The flow of flood in the digestive system |

| Nu | E-module Component | Design Content |
|---|---|---|
| | | 2) Digestive organ function<br>- Mouth : Tongue, Teeth and salivary Glands<br>- Esophagus<br>- Gastric<br>- Small intestine<br>- Colon<br>- Rectum<br>c) Chapter 3. Disorders of the Digestive System<br>- Diarrhea<br>- Constipation<br>- GERD<br>- Appendicitis<br>- Hemorrhoids |
| **4** | Evaluation | Scientific Literacy Test<br>Learning Outome Test |
| **5** | Closing | References<br>Index<br>Glossary |

Based on table 2, shows that the developed digestive system e-module based integrated-STEM is divided into five main components, namely (1) Preface; (2) Introduction; (3) Learning Component; (4) Evaluation; and (5) Closing. The parts in the e-module can be described as follows:

1) Cover.
   Cover contains the title of the e-module, the intended level of education, the material presented in the e-module and the compiler of the textbook.
2) Table of Contents.
   The table of contents is a page description of important content in the e-module. The use of a table of contents can make it easier for teachers and students to find the desired content quickly and efficiently.
3) About STEM and Science Literacy.
   The page on STEM and scientific literacy is a brief description intended as information to students that the e-module developed is based on the STEM approach and can train scientific literacy. The STEM approach in e-module consists of 4 aspects, namely: (1) Science; (2) Technology; (3) Engineering; and (4) Mathematics. Meanwhile, the scientific literacy that was trained in the developed e-Module covers four domains, namely: (1) the context of science; (2) Science knowledge; (3) Science competence; and (4) scientific attitude.
4) Module Components.
   This page presents some of the features available in the e-module. On this page, students can see the entire contents of the e-module briefly. The components presented in the e-module include: (1) learning activities; (2) About Science; (3) Article Corner; (4) Science TV; and (5) Work Sheet.
5) Main dan Basic Competence and Learning Objectives page.
   On this page presented main and basic competence, and learning objectives that must be achieved by students during the learning process.
6) Concept Map.
   The concept map page contains a systematic chart that states the relationship between one concept and another in the e-module.
7) Learning Materials. The developed E-Module is an e-module on the material of the human digestive system. The material in the e-module is divided into 3 sub-chapters, namely: (1) Food substances; (2) The structure and function of the digestive system; and (3) Digestive system disorders. The developed e-module is based on the STEM approach and can train scientific literacy. The STEM approach in e-module consists of 4 aspects, namely: (1) Science; (2) Technology; (3) Engineering; and (4) Mathematics. Meanwhile, the scientific literacy that was trained in the developed e-Module covers four domains, namely: (1) the context of science; (2) Science

knowledge; (3) Science competence; and (4) scientific attitude. The relationship between the STEM approach and scientific literacy in e-modules is presented in table 4.

8) Bibliography.
   The bibliography page contains the resources used in the preparation of the human digestive system e-module based on STEM to train scientific literacy.
9) Glossary and Index.
   The glossary contains a list of definitions of terms contained in the material. While the index is the definition of important terms or words that are arranged in alphabetical order and information on the page where the term or word can be found.

**Table 4. The relationship between STEM aspects and scientific literacy in e-modules**

| Nu. | Module Components | STEM Aspects | Scientific Literacy |
|---|---|---|---|
| 1 | Chapter 1: Article Corner on carbohydrate diet<br>Chapter 2: Article Corner on cholesterol<br>Chapter 3: Work sheet 1 about GERD | Science | Science Context |
| 2 | Chapter 1: Carbohydrate Processing Technology<br>Chapter 2: Cholesterol measuring device<br>Chapter 3: Gastric Endoscopy | Technology | Content Knowledge |
| 3 | Chapter 1: Counting Daily Calories<br>Chapter 2: Normal cholesterol levels | Mathematics | Procedural Knowledge |
| 4 | Chapter 3 : Making GERD candy | Engineering | Science Competence |

## 4. CONCLUSION

The developed of e-module is based on a STEM approach consisting of four aspects, namely: (1) Science; (2) Technology; (3) Engineering; and (4) Mathematics. This module is developed to increase students' scientific literacy for four domains, namely: (1) the context of science; (2) Science knowledge; (3) Science competence; and (4) scientific attitude. The final product of the learning using e-module is gerd candy made by students. For the future research can be done by validaton to dissemination.

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