STEM-CP (Sains, Technology, Engineering Mathematics, And Contextual Problem)-Based Biology Textbook on Food Digestion System in High School

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ABSTRACT
This study aimed to develop a digestive system textbook based on STMCpE for grade XI high school. The textbook set to be a contextual textbook with problem-solving characteristics in the "Food Digestion" material. Food digestion was selected based on the consideration that it contains the scope of science related to technologies that can be engineered by considering mathematical calculations. Food digestion materials also bear contextual problems in the community regarding nutritional security. Hence, students are expected to solve problems regarding the availability of food as an appropriate source of nutrition. The STMCpE textbook was tested its validity, practicability, attractiveness, and effectivity. A pretest-posttest design was applied. Quasi experiment research method with Pretest-Posttest without the control class. Analysis of the data is used by the mixed method, which is the result of qualitative and quantitative data. The sample used was 30 students of class XI high school with problems. The result is that students' critical thinking skills are very good.

Key Words: STEM-CP, Biology Textbook, Food Digestion System.

INTRODUCTION
Biological materials that are considered difficult and often caused misconceptions are; a) body mechanism, b) system, and mechanism of internal organs [1,2]. This digestive system topic will discuss factual knowledge about the digestive organs and disorders of the digestive system; conceptual knowledge includes nutrition in food ingredients and digestive processes; procedural knowledge includes testing various food substances; and metacognitive knowledge about how to prevent digestive system disorders [3]. Teachers consider these as the reason why this mastery of subject matters is not optimal [4]. Several mental activities are required to improve problem-solving capacities that exist in life, namely, critical thinking skills that include the ability to access, analyze, and synthesize information [5]. The solution to resolve the
One factor that supports the habit of students learning through the scientific process is the availability of quality teaching materials. Teaching material is a learning tool containing a set of knowledge that is compiled in an interesting, systematic way, and contains the overall competencies that must be mastered by students to achieve the specified learning goals [7]. One suitable teaching material used for student learning is teaching material based on the STMCpE (Science, Technology, Mathematics, Contextual Problem, and Engineering) approach. An STMCpE approach is an approach of perfecting the STEM approach that is complemented by contextual problems. The term STEM itself was launched by the United States National Science Foundation in the 1990s as the theme of the education reform movement in the four disciplines, namely science, technology, engineering, and mathematics, to increase the number of human resources who master STEM fields, develop citizens STEM literate countries, and increasing US global competitiveness in science and technology innovation [8], but STEM has not been able to solve conceptual problems with appropriate concepts. So with the STMCpE-based textbooks, students can be helped by the material or concepts being taught so that students can find things happening in the community related to the digestive system material and find solutions to these problems.

**METHODOLOGY**

This research was a quasi-experimental research with one group pretest-posttest design. The population used in this study was 30 students of class XI IPA 1 first semester. This study does not use a comparison class but has used a pre-test (pretest) to determine the extent of student understanding of the digestive system material. The students were given treatment by learning the digestive system material using the STMCpE-based digestive system textbooks. After the treatment, students were given a final test (posttest). The instrument of evaluation consisted of 5 questions that depicted the indicator of critical thinking postulated by [9] including interpretation, analysis, inference, evaluation, explanation, and self-regulation.

Analysis of the data obtained from this study is qualitative and quantitative. The results of the qualitative data of students are in the form of descriptive data students' critical thinking skills, while quantitative data obtained from the ability of students to think critically with score criteria, namely:

| Table 1. Criteria for Assessment of Critical Thinking Ability in Students |
|---------------------------|---------------------|
| Skor | Criteria |
| 4 | Strong |
| 3 | Acceptable |
| 2 | Unacceptable |
| 1 | Weak |

Source: Facione, 2013

**RESULT AND DISCUSSION**

Textbooks are a form of printed material developed as a learning resource. Textbooks can be used as a source of reference for educators in implementing the learning process [10]. Textbooks are also manuals for students in learning activities that contain subject matter, inquiry activities based on concepts, scientific activities, information, and examples of the application in daily life. Textbooks contain material about specific subjects or fields of study, which are arranged systematically and have been selected based on learning objectives and the development of students [11].
The STEM approach is one of the learning approaches that can accommodate the characteristics of 21st century learning. Through the STEM approach students not only learn about theories and concepts, but also drill have the skills to think through critical thinking, creative, be able to solve problems, make decisions and how to work through collaboration and communication, the STEM approach was adopted to strengthen the implementation of the National Curriculum [12]. The contextual problems are problems that are present in daily lives so that teachers can empower students to the fullest potential, which prioritizes real experiences, high-level thinking, student-centered, problem solving, active, critic, and creative students. Students are practicing not memorizing [13].

The textbook used is an STMCpE based textbook, which is a textbook with a STEM approach accompanied by contextual problems expected to be able to improve students' critical thinking skills. Stages contained in this STMCpE textbook are contextual problems associated with problems that occur in everyday life regarding technological innovations on problems related to the digestive system. In the science aspect, the textbook will discuss factual knowledge about digestive organs and digestive system disorders; conceptual knowledge includes nutrition in food ingredients and digestive processes; procedural knowledge includes testing various food substances; and metacognitive knowledge on how to prevent digestive system disorders. From the aspect of technology, this unit will discuss technological innovation from the concept of science. From the aspect of engineering, students will be asked to design solutions to contextual problems.

Critical thinking skills data was obtained from the pretest and posttest scores following the indicators of students' critical thinking and contextual problems that must be solved by students. The data is presented in Table 2 and Figure 1.

| Score | Percentage of pretest | Percentage of posttest |
|-------|-----------------------|------------------------|
| 4     | 4.75 %                | 42.6 %                 |
| 3     | 15.25 %               | 40.4 %                 |
| 2     | 25 %                  | 10.25 %                |
| 1     | 55 %                  | 6.75 %                 |

Based on the data above, the score of the pretest before treatment was relatively low and improved after using the textbook based on STMCpE, or improved from weak to acceptable category.
CONCLUSION
Based on the result, it can be concluded that the critical thinking skill of students showed an increase from the initial weak category to the acceptable category. The ability of students to think critically also increased after learning using the STMCpE-based textbook. This improvement is a sign that students understand concepts correctly and can apply their knowledge to solve problems in their lives.

REFERENCES

[1] Karagos, M. & Cakir, M. 2011. Problem solving in genetics: conceptual and procedural difficulties. Educational Sciences: Theory & Practice. 11(3): 1668-1674.

[2] Henno, I. & Reiska, P. 2009. Using concept mapping as assessment tool in school biology. Concept Mapping: Connecting Educators. (Proc. Of the 3rd International Conference on Concept Mapping).

[3] Hendriani.H. (2013). Proses Resilieni Individu Terhadap Perubahan Kondisi Fisik Menjadi Penyandang Disabilitas. Disertasi. Program Studi Psikologi.Fakultas Psikologi Universitas Airlangga. Surabaya Jawa Timur.

[4] Adriani, S & Lazuardi. 2016. Analisis kesulitan belajar siswa pada materi pokok sistem indra manusia (penglihatan, pendengaran, dan pengecap) di kelas XI IPA MAN Stabat. Jurnal Pelita Pendidikan. 5: 404-409

[5] Redecker, C., et al. (2011). The Future of Learning: preparing for change. Luxembourg: Publications Office of the European Union. Hamid, H. 2013. Pengembangan Sistem Pendidikan di Indonesia. Bandung: Pustaka Setia.

[6] Lestari, I. 2013. Pengembangan Bahan Ajar Berbasis Kompetensi Sesuai dengan Kurikulum Tingkat Satuan Pendidikan. Padang: Akademia Permata.
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[7] Hanover Research. (2011). A crosswalk of 21st century skills. Hanover: District Administration Practice

[8] Facione. (2013). Critical Thinking: What It Is and Why It Counts. Measured Reasons and The California Academic Press, Millbrae, CA.

[9] Norlidah Alias, D. D. 2016. Effectiveness of the Biology PTechLS Books in a Felda Science Centre. Malaysia Online Journal of Educational Technology, 2-13.

[10] Abdul, M. 2017. Pengembangan Bahan Ajar Kenampakan Bumi Berbasis Keterampilan Proses Melalui Pendekatan PCK di SMP. Skripsi. Bandung. Pendidikan IPA. UPI Bandung.

[11] Asmuniv. 2015. Pendekatan Terpadu Pendidikan STEM Upaya Mempersiapkan Sumber Daya Manusia Indonesia Yang Memiliki Pengetahuan Interdisipliner dalam Menyosong Kebutuhan Bidang Karir PekerjaanMasyarakat Ekonomi ASEAN (MEA).

[12] Birgili, B. 2015. Creative and Critical Thinking Skills in Problem-based Learning Environments. Journal of Gifted Education and Creativity, 2(2), 7180 hlm.
