

Comprehension of Biology Concept in the Human Respiratory System Based on STEM

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ABSTRACT

Comprehension of concept is very important for student in learning biology, because the subject of biology is conceptual. The subject of biology is interconnected with one another which requires students to comprehension of biology concept in order to learning continue. Comprehension of biology concept is needed so that students remember the biology concept longer so that biology subject are more meaningful for the student. In addition, the purpose of this research is to comprehension of biology concept in the human respiratory system based on STEM. This research is descriptive with 64 student respondents who have studied human respiratory system material. The indicators comprehension of biology concept are interpreting, exemplifying, classifying, summarizing, inference, comparing, and explaining. The instrument of research used 15 essay test questions. The validity test by expert judgment and empirical. Analysis data using SPSS software. The result of comprehension of biology concepts for student showed a mean is 82. There are three categories of comprehension of biology concept consist that is understand, misconception, and not understand. The result showed 81% of student understand, 14% misconceptions, and 5% not understand about concept of biology in the human respiratory system.

Keywords: Comprehension, biology concept, human respiratory, STEM

INTRODUCTION

The mastery of science and technology, especially in the fields of science, technology, engineering, and mathematics, has an important role in the world of education [1]. The integration of these scientific fields is expected to be the key to success in developing a country, especially in the context of 21st century career/skill career development competition at the global level. The STEM was launched by the United States National Science Foundation in the 1990s as the theme of the education reform movement in the four disciplinary fields to increase the number of human resources who master of STEM [2]. The component of STEM consist are Science, Technology, Engineering, and Mathematic. *Science* is the study of natural phenomena involving observation and measurement, as a vehicle to objectively explain the ever-changing nature. *Technology* refers to human innovations that are used to modify nature to meet human needs and desires, so as to make life better and safer. Technology makes humans able to travel quickly, communicate directly with people in distant places. Technology includes not only the products, but also the knowledge and processes needed to create and operate these products. Most modern technology is a product of science and engineering, and technological equipment is used in both fields.

Engineering is the knowledge and skills to acquire and apply scientific, economic, social and practical knowledge to design and construct machines, equipment, systems, materials and processes that benefit people economically and environmentally friendly. The engineering is defined as knowledge about the design and creation of human work products and a process to solve problems in the constraints of time, funds, materials, and environmental regulations. Engineering uses concepts in science and mathematics as well as technological devices [3]. Technology and engineering are different but closely interrelated. The difference between technology and engineering is that engineering can be seen as a process with regard to creating or designing, whereas as a reverse technology it can be seen as a product of that process [4]. Engineering activities result in the transformation of matter, energy, or information, energy, or information, while technology can be seen as things that result from engineering [5]. In addition, *mathematics* deals with patterns and relationships, and provides relationships for technology, science, and engineering [6]. Through STEM evaluation, it is expected to be able to create human resources (HR) who are able to reason and think critically, logically, and systematically, as well as improve communicative, collaborative and problem solving abilities. With increasing human

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resources competences, it is hoped that our country can face global challenges and be able to improve the economy, as well as to realize Indonesia's projections as the seventh largest economy in the world in 2030 [7].

Science, technology, engineering, and mathematics (STEM) is a new part in the development of the world of special education in the biology. The STEM was formed on the integration of several scientific unit. STEM approach is a blend of science, technology, engineering, and mathematics into one curriculum as a whole [8]. The development of the science curriculum is carried out in order to achieve the dimensions of knowledge competence, scientific work, and scientific attitudes as daily behavior in interacting with the community, the environment and using of technology. Knowledge competency assesment is carries out in the mastery of factual, conceptual, procedural, and metacognitive knowledge [9]. The concepts are collections of meanings that capture order (similarities and differences), patterns, or relationships between object, event and other concepts. If the new concept learned by students are in accordace with the concepts they have learned, students will apply the knowledge to new situations, whereas if the new concept is completely different from what they have, students need to change it so that a concept change process occurs. Students' comprehension of scientific concepts in depth requires a change in thinking patterns from applying conventional learning to innovative learning [10]. Therefore in science learning teachers must be able to act as a guide to guide students to begin the learning process. Learning involves the process of student interaction with educators and learning resources in the learning environment [11].

Conceptual change have occurred in students taught by experienced teachers and students taught by teachers who practice. Differences in teachers experience can trigger misconceptions adopted by students. For example, picture of organs in the respiratory system in biology textbooks are reconstructed drawings, not original images of organs. This comprehension can be fostered, among others, by STEM-based learning through modeling the structure of respiratory system organs using materials that are easily obtained in the surrounding environment so that students' comprehension is more correct [12]. The human respiratory system was chosen because there are several important concepts involved in daily life. Starting from the respiratory organs to the rate of respiration that occurs every second [13]. The reseacrh based on STEM learning in Indonesia has not been done much especially those realting to changes in students' conceptions. Based on these explanationsm comprehension of biology concept for students is very important to support problem solving realted to subject matter and the truth of concepts and phenomena that actually occur.

According to Anderson and Krathwohl indicators of comprehension of biology concepts consist of seven, namely are interpreting, examining, classifying, summarizing, inference, comparing, and explaining [14]. Comprehension the concept is also a foundation for students to proceed to the next material of biology. Therefore in the research about comprehension of biology concept in the human respiratory system will be use STEM so students really understand and misconceptions do not occur, because in the STEM approach a biology concept will be linked to science, technology, engineering, and mathematics [15]. So it is not only limited to ordinary concepts, there is proof of concept so that students comprehension more [16]. Education of STEM gives educators the opportunity to show students how concepts, principles and techniques from science, technology, engineering, and mathematics are used in an integrated way in the development of products, processes and systems used in their daily lives. Therefore, the definition of STEM education was adopted as an interdisciplinary approach to learning to improve comprehension of biology concepts [17].

In STEM-based learning students use science, technology, engineering, and mathematics in real contexts that connect between school, the world of work, and the global world, in order to develop STEM literacy that enables students to be able to compete in a new knowledge-based economic era [18]. If students are expected to study STEM well, it must be done by reducing the material currently covered in the curriculum. The connection with the implementation of learning based on STEM, students in basic education need to be encouraged to connect science and engineering [19]. Furthermore, at the level of higher education challenges need to be given to perform authentic engineering tasks as a complement to science learning through project activities that integrate science, engineering, technology, and mathematics [20]. STEM-based science learning needs to be carried out in problem-based learning units, in which students are challenged critically, creatively, and innovatively to solve real problems, which involve collaborative group (team) activities [21].

STEM-based science learning in class is designed to provide opportunities for students to apply academic knowledge in the real world [22]. STEM education based learning experience is expected to

develop students' understanding of science content, innovation abilities and problem solving, soft skills (including communication, collaboration, leadership) [23]. The integration of STEM education in biology can be done through gradual habituation related to learning, starting from the emphasis on habit of asking questions, through inquiry training models, scientific inquiry with scientific processes, to the application of scientific literacy, technological and engineering literacy [24]. STEM education literacy through DDO empowerment, cross cutting concepts to multiple intelligences, soft-skills and engineering practice design, both assisted by IT or ICT, as well as entrepreneurship. It is time for undergraduate and graduate student research to be directed to contribute to the development of STEM education [25].

RESEARCH METHOD

This type of research is quantitative descriptive research. The sampling technique used in this study is simple random sampling, this technique is used to provide equal opportunities to each member of the population to be sampled. The research respondents were 64 students in the grade 11. This research instrument use 15 essay tests to measure the understanding of biological concepts in STEM-based human respiratory system material. The test in the form of this essay was conducted to find out the comprehension of biology concept based on STEM. Comprehension of biology concept indicators used consist of 7, namely: interpreting, exemplifying, classifying, summarizing, inference, comparing, and explaining. Comprehension of biological concepts is divided into several categories, namely understanding, misconception and not understanding then converted into percentages. Procedures for data collection of test instruments were validated by experts (expert judgment), then the validity and reliability of the instruments were tested using SPSS. Test instruments were used to obtain information about comprehension of biology concepts in STEM-based in the human respiratory system material. The data that has been obtained will then be analyzed using SPSS and Microsoft Excel to see the level of achievement based on percentage. The formula used for valuation is the total score of the correct questions divided by the maximum score of the test is then multiplied by 100

RESULTS AND DISCUSSION

The instrument test used in the form of essays totaled 15 questions. The instrument consists of several indicators there are interpreting, exemplifying, classifying, summarizing, inference, comparing, and explaining for interpretation the comprehension of biology concept. The validity of the instrument uses validity by experts judgment namely biology material experts on human respiratory system materials and STEM experts in education. Then the empirical validity is done and analyzed using the SPSS program. It is known that of the 15 questions only 13 questions were declared valid with a significance value ≥ 0.2461 . Whereas 2 invalid question numbers were fixed. So the test instruments used in this study still totaled 15 questions.

Table 1. Validity the validity of instruments comprehension of biology concepts

Significant	Information	Item number	Total
$\geq 0,2461$	Valid	1, 2, 3, 4, 5, 7, 9, 10, 11, 12, 13, 14, 15	13

Descriptive statistical analysis using the SPSS program found that the average was 82, the median was 77.78, the maximum score obtained was 85.65 and the minimum score obtained was 67.79. Data taken through test results (essays) about comprehension of biology concept can be interpreted as high if they have scores more than the total score and are categorized as low if they find scores below the average or less than the average total score used as a sample in the research.

Table 2. Descriptive statistics analysis

Statistic	Comprehension of biology concepts
Mean	82
Median	77,78
Standar deviation	10,00608
Skor max	85,65
Skor min	67,79

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The comprehension is the ability of someone to understand or understand something after something is known and desired [26]. In other words, comprehension is knowing something and being able to see it from various aspects. Student comprehension something if they can give an explanation or give a more detailed description about it by using their own words. Therefore comprehension is a level of thinking ability that is one level higher than memory or memorization [27]. According to Anderson and Krathwohl, comprehension of biology concept has 7 indicators namely explaining, comparing, inference, summarizing, classifying, exemplifying, and interpreting.

The research results obtained data on the comprehension of biology concepts in human respiratory system material as follows. For explaining as much as 89, for comparing as much as 70, for inference as much as 66, for summarizing as much as 76, for classifying as much as 88, for examining as much as 80, for interpreting as much as 78. Of the seven indicators comprehension of biology concept based on STEM, the highest percentage is obtained explaining that is 89%, this is because students are able to explain the concepts that have been studied based on STEM. Students are able to explain using technology, based on calculations (mathematics) or using engineering.

The lowest indicator of inference is 66%, this is because students find it difficult to deduce concepts they have understood but when explaining they can provide an explanation. the comprehension of biology concept a person's can be influenced by several factors including the ability to think someone, the genetic makeup of parents, the environment, social, economic, cultural, and education. Understanding the concept is often used to explain the characteristics of other concepts, so that more concepts owned by someone will provide an opportunity for him to understand other concepts more broadly so that it can be a capital to solve problems around him [28].

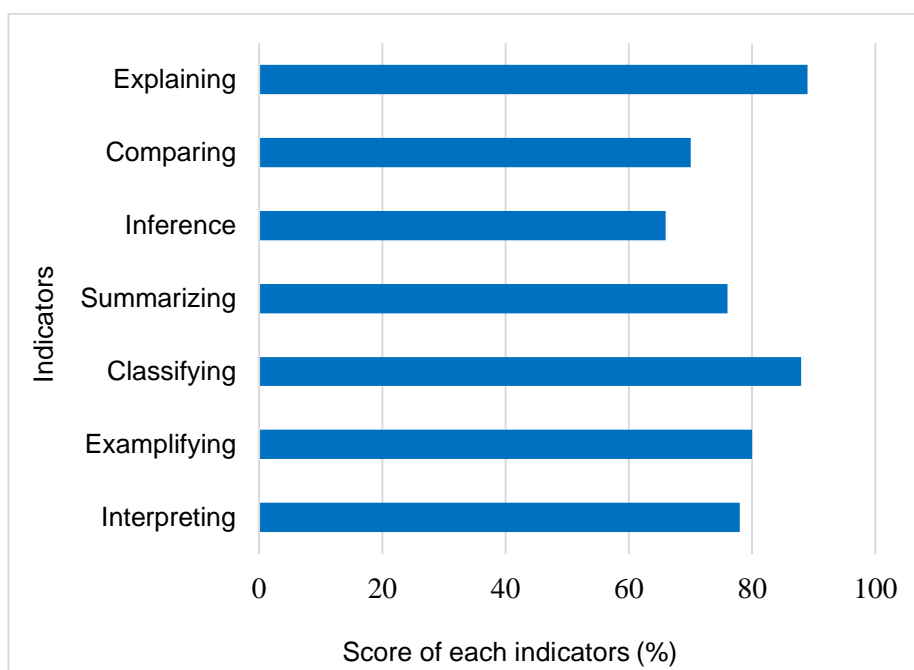


Figure 1. Percentage of indicators comprehension biology concepts

This research aims to determine the understanding of students' biology concepts based on STEM. The instruments were made in the form of tests (essay questions), where the questions contained STEM-based approaches. The results of data analysis showed the percentage of three categories of students in comprehension of biology concept. the first category was understand by 81%, the category of misconception by 14%, and the category did not understand by 5%. This can be interpreted that in this research about comprehension of biology concept based on STEM in the human respiratory system is categorized as understand.

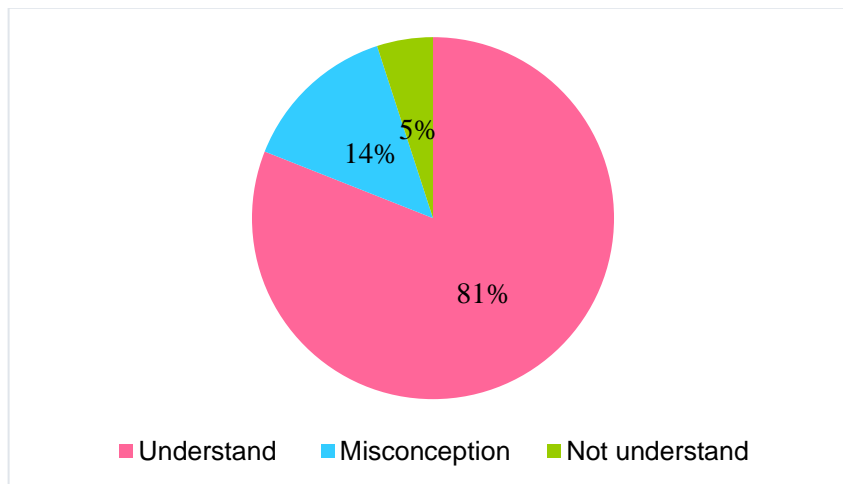


Figure 2. The categories of comprehension of biology concept

CONCLUSIONS

The comprehension of concept is important instilled in students as a basis for understanding a lesson, so students are able to solve problems related to concepts in the subject matter and avoid misconception the concepts. the comprehension of biology concept can be done using the STEM approach, in the STEM there is a relationship between science, technology, engineering, and mathematics so that specifically the biology concepts in human respiratory system materials can be directly understood by students for example by providing concrete examples and exist in the environment. The existence of STEM in improving understanding of concepts means understanding of biology concepts (science) can be proven by using technology, engineering from techniques and mathematical calculations. So understanding students' concepts will be stronger.

REFERENCES

- [1] S. Freeman *et al.*, "Active learning increases student performance in science, engineering, and mathematics," *Proc. Natl. Acad. Sci. U. S. A.*, 2014.
- [2] M. Sanders, "STEM, STEM education, STEMmania," *Technol. Teach.*, 2009.
- [3] A. Zollman, "Learning for STEM Literacy: STEM Literacy for Learning," *Sch. Sci. Math.*, 2012.
- [4] L. D. English, "STEM education K-12: perspectives on integration," *International Journal of STEM Education*. 2016.
- [5] M. B. Ibáñez and C. Delgado-Kloos, "Augmented reality for STEM learning: A systematic review," *Comput. Educ.*, 2018.
- [6] M. Stohlmann, T. Moore, and G. Roehrig, "Considerations for Teaching Integrated STEM Education," *J. Pre-College Eng. Educ. Res.*, 2012.
- [7] T. R. Kelley and J. G. Knowles, "A conceptual framework for integrated STEM education," *International Journal of STEM Education*. 2016.
- [8] L. S. Nadelson, J. Callahan, P. Pyke, A. Hay, M. Dance, and J. Pfiester, "Teacher STEM perception and preparation: Inquiry-based stem professional development for elementary teachers," *J. Educ. Res.*, 2013.
- [9] C. L. Greenleaf *et al.*, "Integrating literacy and science in biology Teaching and learning impacts of reading apprenticeship professional development," *Am. Educ. Res. J.*, 2011.
- [10] K. Illeris, "Towards a contemporary and comprehensive theory of learning," *Int. J. Lifelong Educ.*, 2003.
- [11] K. Illeris and K. Illeris, "A Comprehensive Understanding of Human Learning," in *Learning, Development and Education*, 2019.
- [12] D. F. Treagust, G. Chittleborough, and T. L. Mamiala, "Students' understanding of the role of scientific models in learning science," *Int. J. Sci. Educ.*, 2002.
- [13] D. Kuhn, "Teaching and learning science as argument," *Sci. Educ.*, 2010.
- [14] D. R. Krathwohl and L. W. Anderson, "Merlin C. Wittrock and the revision of bloom's taxonomy," *Educ. Psychol.*, 2010.

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- [15] H. Firman, "Pendidikan Sains Berbasis Stem: Konsep, Pengembangan, Dan Peranan Riset Pascasarjana," in *Seminar Nasional Pendidikan IPA dan PKLH*, 2015.
- [16] M. A. Honey, G. Pearson, and H. Schweingruber, *STEM integration in K-12 education: status, prospects, and an agenda for research*. 2014.
- [17] J. D. Basham and M. T. Marino, "Understanding STEM Education and Supporting Students through Universal Design for Learning," *Teach. Except. Child.*, 2013.
- [18] S. Olson and J. Labov, *STEM learning is everywhere: Summary of a convocation on building learning systems*. 2014.
- [19] L. Thibaut *et al.*, "Integrated STEM Education: A Systematic Review of Instructional Practices in Secondary Education," *Eur. J. STEM Educ.*, 2018.
- [20] T. J. Kennedy and M. R. L. Odell, "Engaging Students In STEM Education," *Sci. Educ. Int.*, 2014.
- [21] K. Billiark, J. Hubelbank, T. Oliva, and T. Camesano, "Teaching STEM by design," *Adv. Eng. Educ.*, 2014.
- [22] Y. Xie, M. Fang, and K. Shauman, "STEM Education," *Annu. Rev. Sociol.*, 2015.
- [23] J. Brown, "The Current Status of STEM Education Research.," *J. STEM Educ. Innov. Res.*, 2012.
- [24] H. Kanematsu and D. M. Barry, *STEM and ICT Education in Intelligent Environments*. 2016.
- [25] F. Scheuermann and F. Pedró, *Assessing the effects of ICT in education: Indicators, criteria and benchmarks for international comparisons*. 2010.
- [26] D. C. Rice, J. M. Ryan, and S. M. Samson, "Using Concept Maps to Assess Student Learning in the Science Classroom: Must Different Methods Compete?," *J. Res. Sci. Teach.*, 1998.
- [27] V. Rajlich and N. Wilde, "The role of concepts in program comprehension," in *Proceedings - IEEE Workshop on Program Comprehension*, 2002.
- [28] N. Afifah *et al.*, "Kemampuan Berpikir Kritis Dan Pemahaman Konsep Ipa," *Unnes J. Biol. Educ.*, 2013.