# The Effectiveness of Respiratory System E-Module Based STEM to Improve Conceptual Understanding and Caring Attitudes towards the Dangers of Cigarettes in High School Students

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## Abstract
An independent curriculum is a curriculum that requires active students. One way to make students active is through respiratory system e-module based STEM. This research aims to measure the validity, readability, and effectiveness of respiratory system e-module based STEM to improve conceptual understanding and caring attitudes towards the dangers of smoking in high school students. Large-scale tests are carried out in classes XI SMA Negeri 1 Payung as much 70 students and SMA Negeri 1 Pulau Besar as much 50 students by using the results of conceptual understanding and assessing caring attitudes towards the dangers of smoking. The results of students' conceptual understanding showed that average N-gain of 0.45 in the medium category. The assessment score for caring about the dangers of smoking among students obtained an average percentage score of 96.5% in the very good category. Based on the research results, it can be concluded that the respiratory system e-module based STEM developed is valid and effective to improving conceptual understanding and caring attitudes towards the dangers of smoking in class XI.

## How to Cite

## INTRODUCTION

Learning is a term related to a process. The learning process takes place through various methods and media to explain, analyze and develop a message or material as an embodiment of achieving learning objectives. Learning cannot be separated from learning sources (Prihatin. et al., 2024). Learning resources are defined as information presented and stored in various forms of media (Syahvira Indah Puspita & Sari, 2024). Apart from using learning resources, an optimal learning process is also supported by the use of teaching materials. Teaching materials have a role in learning (R. Septianingsih et al., 2023). Students need biology teaching materials to overcome difficulties in understanding biology material (Tarigan and Zulkarnein, 2023), develop higher thinking skills (Purwanti, 2024), and improve activeness in learning (Sari et al., 2023). According to Zuleni and Marfilinda (2022) in learning activities teachers should use teaching materials that are in accordance with the development of methods, characteristics and needs of students in order to improve students' conceptual understanding.

Interactive e-modules can help students develoInteractive e-modules can help students develop knowledge and improve students' abilities independently in learning material, both in class and distance learning (Setyaningrum et al., 2024), because teachers act as facilitators and mediators (Afriani et al., 2024). E-modules are useful for students because they contain clear objectives, learning materials and activity sheets and can check students' understanding independently (Zakaria et al., 2024). Apart from that, e-modules can also improve students' interest in learning (Noris et al., 2024). The results of research by Rizal and Genisa (2024), using e-modules can present material with multimedia such as videos, animations, simulations, and questions with direct feedback, so that learning content becomes more dynamic, effective, and fun.

The implementation of e-modules is prepared based on a study of learning outcomes and the flow of learning objectives as stipulated in the independent curriculum standards (Ali, 2024). The independent curriculum contains various learning outcomes that can be adapted to e-modules (Khusna et al., 2024). One of the CPs in biology material related to the respiratory system is that students have the ability to analyze the relationship between the structure of organs in the respiratory organ system and their function as well as abnormalities or disturbances that arise in the organ system. Students have the

ability to apply concepts in everyday life (Orbitha et al., 2020). The concepts learned are applied to solve life problems which are resolved using process skills independently until they are able to overcome these problems (Refmianti et al., 2023). Process skills are also built on the scientific attitude and profile of Pancasila students which can be adapted to e-modules on the biology of the respiratory system, namely planning and carrying out observations of the effects of air pollution and processing information on some of the negative risks of smoking in teenagers to determine decisions. This CP can be included in the e-module so that students can learn more about the dangers of smoking and care about their health.

Smoking behavior is common, especially among teenage and adult men (Ummi, 2024). Global Youth Tobacco (GYT) research shows that the prevalence rate of teenage smoking in Indonesia is very worrying. It is estimated that of the 70 million Indonesian children, 37% or the same as 25.9 million Indonesian children are smokers and this number makes Indonesia the country with the largest number of smokers in Asia. Even though many people know the bad effects of smoking, the number of smokers has never decreased and in fact tends to improve (Solihin et al., 2023).

The negative impact of smoking is the basis for the importance of education about smoking. This can be applied in learning, one of which is by applying it to e-modules. The results of interviews with several class the teacher has not tried to explore and provide deeper information regarding the dangers of smoking for maintaining human respiratory organs. This is very unfortunate because smoking behavior is currently very worrying because it has spread among teenagers who are actually students.

The results of research by Kodir et al., (2022), concluded that there is an influence of health education on knowledge about the dangers of smoking among students among teenagers. Apart from that, the research results of Mahyar Suara et al., (2020), also concluded that health education about the dangers of smoking has been proven to reduce cigarette consumption in adolescents. A good level of physical, mental, social and spiritual health in students will support student success in learning. Students who are successful in learning have a greater opportunity to achieve success in the future. In principle, health education aims to ensure that students behave in accordance with the values of healthy living (Syukaisih et al., 2022).

Interactive e-modules can help students

develop knowledge and improve students' abilities independently in learning material, both in class and distance learning. Based on the results of observations at high school students, the use of e-modules has been carried out well. The results of the analysis of several textbooks used, especially material on the respiratory system, the explanation of the material is good, however in the sub-chapter the dangers of smoking for health are only explained briefly and not in detail. The material should be presented in detail so that students can understand and realize that smoking is dangerous for health, especially the lungs. Apart from that, if the material is applied it will be effective in learning and students are expected to stop smoking because they are aware of the health importance of the dangers of smoking.

Good implementation of e-modules cannot be separated from an appropriate learning approach (Junedi et al., 2024). One of the approaches used in this research is the STEM approach. STEM is an abbreviation for an interdisciplinary learning approach between Science, Technology, Engineering and Mathematics. According to Zulyusri et al. (2023), STEM allows students to learn academic concepts precisely by applying four disciplines (science, technology, engineering skills and mathematics). The aim of STEM education is for students to have scientific and technological literacy which can be seen from reading, writing, observing and doing science so that when they enter society in the future, they will be able to develop the competencies they already have to apply them in dealing with problems in everyday life related to STEM fields of science (Sungur, 2023).

Relevant previous research has analyzed the application of the validity and practicality of e-books based STEM on respiratory system material as well as the validity of learning media. This condition strengthens the reasons for carrying out further research on updates. Therefore, a respiratory system e-module based STEM was developed to increase conceptual understanding and caring attitudes towards the dangers of smoking in high school students.

Based on the scope above, the formulation of the problem in this research is: (1) What are the characteristics of the respiratory system e-module based STEM, (2) What is the validity of the respiratory system e-module based STEM (3) What is the readability of the respiratory system e-module based STEM (4) How is the respiratory system e-module based STEM for improving conceptual understanding in high school students, (5) How is the respiratory system e-module based STEM in fostering a caring attitude towards the dangers of smoking in high school students. Based on the problem formulation above, the objectives of this research are: (1) Describe the characteristics of the respiratory system e-module based STEM, (2) Determine the validity of the respiratory system e-module based STEM, (3) Determine the readability of the respiratory system e-module based STEM, (4) Analyze the respiratory system e-module based STEM to improve conceptual understanding in high school students, (5) Analyze the respiratory system e-module based STEM to foster a caring attitude towards the dangers of smoking in high school students.

## METHOD

The subjects in this research were class XI students of SMA Negeri 1 Payung, totaling 70 people and class XI students of SMA Negeri 1 Pulau Besar, totaling 50 people. Data collection techniques used expert validation questionnaires, e-module readability questionnaires, concept understanding questionnaires, and attitude questionnaires regarding the dangers of smoking. Data analysis used to determine concept understanding was tested using N-Gain. While the validity of teaching materials, readability of e-modules and attitudes about the dangers of smoking used descriptive analysis.

N-Gain test formula:

$$N\text{-}Gain = \frac{Skor\ posttest - skor\ pretest}{Skor\ ideal - skor\ pretest}$$

**Table 1.** Normalized Gain Criteria

| No | Normalized Gain Value | Interpretation |
|----|----------------------|----------------|
| 1  | $0{,}71 < g \leq 1$   | High           |
| 2  | $0{,}31 < g \leq 0{,}70$ | Currently   |
| 3  | $0{,}00 < g \leq 0{,}30$ | Low         |

(Hake, 1998)

## RESULT AND DISCUSSION

### Characteristics of The Respiratory System E-Module Based STEM

E-module is an independent learning resource for students which has been arranged systematically, interactively and dynamically into a learning unit which is presented in electronic form, where each learning activity in it is connected with a link as navigation which makes students more interactive with The program is also equipped with the presentation of learning

videos, animations and interactive quizzes or questions to enrich students' learning experience. E-modules are teaching materials that can be accessed using electronic devices such as cellphones or laptops, created to train students to be able to carry out learning activities independently.

The product developed in this research is a respiratory system e-module based STEM to increase conceptual understanding and caring attitudes towards the dangers of smoking in high school students. The e-module developed contains the concept of respiratory system material and discusses the negative risks of smoking. The e-module developed contains additional material related to respiratory system disorders caused by smoking. The e-module developed is integrated with STEM-based learning. The e-module contains learning outcomes and learning objectives that are in accordance with the respiratory system material. In the e-module section there are summaries and formative questions in multiple choice form which can be checked directly for completeness. Formative questions can be done many times until students have completely finished them. The e-module is in the form of a flipbook designed with the heyzine application. The e-module contains materials, videos and questions to train students' understanding of concepts. The e-module contains pretest-posttest questions which can only be done once.

E-modules as good teaching materials must have several characteristics, namely self-instruction, self-contained, stand alone, adaptive and user friendly. E-module is a teaching material like the modules used in learning but the presentation uses electronic media. So the characteristics of the respiratory system e-module based STEM are the same as the module characteristics. Self instructional, which can be used for independent learning. Self contained, that is, it contains the subject matter studied. Stand alone, that is, it can be a learning medium on its own without the need for other media. Adaptive, namely modules according to student characteristics. User Friendly, namely easy to use. A quality e-module requires knowledge of the components in the e-module. The Ministry of National Education in 2008 explained that a module should at least contain: study instructions, competencies to be achieved, material content, supporting information, exercises. worksheets, evaluations, and feedback on evaluation results. Researchers have used the module components above in developing a respiratory system e-module based STEM. Each component in the e-module complements each other, therefore, in preparing the e-module,

the components must be complete and correct.

Learning consists of three activities. Each activity contains the four principles of STEM (science, technology, engineering, and mathematics), and is integrated into three learning activities. In the first learning activity, students study material related to the structure and function of organs contained in the material description (principles of science), then students observe videos (principles of technology), then students work on designing images of respiratory organs according to the sequence of the respiratory system (principles of engineering), and students collect respiratory frequency data based on age (mathematical principles). In the second learning activity, students study material related to respiration mechanisms (science principles), observe videos (technology principles), then students work on project assignments to make reports related to practical results (engineering principles), and students do practical work on calculating lung capacity (mathematic principles). In the third learning activity, students study material related to respiratory system disorders caused by smoking (principles of science), then students do independent assignments looking for information on the internet related to technology in the health of the respiratory system (principles of technology), students do project assignments to make posters related to the dangers of smoking (principles of engineering), and students attach data on the percentage of smokers by age to the poster (mathematical principles).

**Validity of Respiratory System E-Module Based STEM**

The validity of teaching materials is assessed by 2 validators, namely material experts and media experts. Teaching materials are said to be valid if the percentage of assessments by media and material validators is > 62% (Sudijono, 2012). The results of the validity assessment of teaching materials show that there are advantages and disadvantages of teaching materials.

**Table 2.** Assessment results by material experts and media experts

| Evaluation | Percentage (%) | Category |
|---|---|---|
| Material Expert | 89.9 | Very Valid |
| Media Expert | 91.2 | Very Valid |

Judging from the percentage of validity of teaching materials, the material expert's assessment was 89.9% in the very valid category.

The assessment with these results shows that the components of suitability of language, graphics, and suitability of the learning approach in the e-module are as expected. In the aspect of conceptual understanding and caring about the dangers of smoking in the e-module, it is in accordance with Indonesian language rules.

The media expert's assessment was 91.2%, indicating that the display components and use of the e-module were as expected. The validator states that teaching materials can be applied in classroom learning, provided that product revision is required before use. Research by Gafari et al., (2024) shows that teaching materials use good and correct Indonesian language rules, the appearance of the images and designs presented are attractive, the layout presented is interesting and not monotonous, only in the form of writing.

**Readability of Respiratory System E-Module Based STEM**

Test the readability of the e-module using a questionnaire assessing teacher and student responses. The number of teachers used by respondents was 2 biology teachers and the students used as respondents were 10 class XI students. The respiratory system e-module based STEM is said to be good for use in learning if the readability percentage is $\geq 61\%$ (Arikunto, 2011).

**Table 3.** E-module readability test results

| Evaluation | Percentage (%) | Category |
|---|---|---|
| Teachers | 95.5 | Very Good |
| Students | 94.3 | Very Good |

Based on these results, teachers and students assess that the e-module developed has advantages, namely that the respiratory system e-module based STEM so that in the teaching materials there are several real problems and examples that exist in everyday life, so that the teaching materials can arouse students' curiosity. This is in accordance with research by Wati et al., (2024) that learning using the STEM approach is more effective in science output and improving students' curiosity than learning using conventional methods.

The use of e-modules is also equipped with a pre-test and post-test which aims to see changes in students' conceptual understanding before using the e-module and after using the e-module. The research results Rizal and Genisa (2024) show that the e-module with PhET Interactive Simulation for Biology Education students to improving understanding of integrated physics concepts in biology. Using the STEM approach in the learning process can improve students' problem solving abilities and be effective in training critical thinking skills (Novidya and Kustijono, 2019). STEM learning is also effective in the learning process of understanding concepts (Thahir et al., 2020).

E-modules were chosen because they are durable, practical, and can improve students' understanding of concepts (Fauziah et al., 2022). To complete the need for pre-existing e-modules, this e-module has been equipped with practicum videos so that it can improve conceptual understanding and train students' skills directly. By using e-modules, learning is not limited by space and time (Agustia & Fauzi, 2019). This e-module is also connected directly to the web which functions as a place for student assignments that have been uploaded, so that teachers can easily find out the results or provide input to students directly.

Apart from the advantages, according to teachers and students the e-module being developed also has disadvantages, namely that the teaching material contains too much material compared to images. It is recommended that the cover and contents of teaching materials be provided with more attractive images. According to Yuliani et al. (2024), an attractive cover for teaching materials is a cover where the selection and description of the images are clearly visible. Furthermore, according to Aninindya et al. (2022) , teaching materials designed with a scientific approach accompanied by pictures can arouse students' curiosity and interest in studying biology.

**Conceptual Understanding**

Improving students' conceptual understanding can be seen from the N-gain of pretest and posttest scores. Based on the results of the N-gain analysis, it shows that the development of respiratory system e-module based STEM can improve students' conceptual understanding. The average improve in concept understanding score using the respiratory system e-module based STEM was 0.45 in the medium category. The results of the study are similar to the research of Pertiwi (2024) teaching materials with a STEM approach are quite effective for students' learning outcomes with the N-Gain score percentage of the control class being 52% in the less effective category, while in the experimental class it is 60% in the quite effective category.

The STEM approach can train conceptual understanding because the material is related to everyday life. This is in line with Firdaus et al.

(2023) that students' conceptual understanding of measurement material can improve with a STEM approach. According to Subchan et al. (2023) STEM helps students to construct the knowledge they already have with new knowledge they learn independently, so that students better understand the knowledge they have gained to solve the problems they are given. Research conducted by Hutabarat (2024) with the development of STEM module learning media with the 5E learning cycle model in science lessons can improve understanding of concepts in grade 8 of junior high school.

Improving understanding of the concepts in this research can be a benchmark for student success in learning. Research conducted by (Astuti et al., 2024) states that conceptual understanding is a benchmark for the success of a student's learning process. According to Ekasari et al. (2024), in a STEM approach, understanding concepts is very necessary as a measure of the success of teaching and learning because students are faced with problems that require problem solving and solutions related to technology. When students know about problems that are close to their environment, their understanding of concepts can improve. A good understanding of concepts will give rise to students' critical thinking patterns (Syukaisih et al. 2022). This requires teachers to be able to design learning activities to improve students' conceptual understanding (Zuleni & Marfilinda, 2022).

**Concerned Attitude towards the Dangers of Cigarettes**

After learning, students were given a questionnaire regarding their caring attitude towards the dangers of smoking. From the results of the questionnaire, the average score per aspect was 96.5% in the very good category. This can be interpreted that after using the respiratory system e-module based STEM, students' knowledge about the dangers of smoking improves, so it is hoped that students will reduce smoking behavior. This is in accordance with research by Fakhreni and Hutasuhut (2023) there is a significant relationship between knowledge and smoking behavior at SMP Negeri 1 Kuta Limbaru. Students who receive education about the negative impacts of smoking are expected to stop smoking.

Health education can influence the improve in students' caring attitudes. This research is in accordance with Amali et al. (2024) which states that providing health education can improve understanding and caring attitudes towards a healthy living culture. The results of research by

Kodir et al. (2022), concluded that there is an influence of health education on knowledge about the dangers of smoking among students among teenagers. Apart from that, the research results of Mahyar et al. (2020), also concluded that health education about the dangers of smoking has been proven to reduce cigarette consumption in adolescents. A good level of physical, mental, social and spiritual health in students will support student success in learning. Students who are successful in learning have a greater opportunity to achieve success in the future. In principle, health education aims to ensure that students behave in accordance with the values of healthy living (Syukaisih et al., 2022).

## CONCLUSION

The characteristics of the respiratory system e-module based STEM include the integration of subject matter with the fields of science, technology, engineering and mathematics. There are features that can stimulate students' conceptual understanding and caring attitudes. The respiratory system e-module based STEM is valid for use in learning based on assessments from material and media experts. Teacher and student readability of the respiratory system e-module based STEM is very good. The respiratory system e-module based STEM is improving students' conceptual understanding as shown by an average N-Gain value of 0.45 in the medium category. The respiratory system e-module based STEM is fostering students' caring attitude towards the dangers of smoking as shown by an average of 96% in the very good category.

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