



## The Validity of Research-Based Teaching Supplements to Improve Students' Scientific Literacy

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### Abstract

The development of teaching supplements based on research results regarding the dangers of vaping needs to be conducted considering that there is no integration regarding the dangers of vaping in biology subjects. Students need to improve information about the dangers of vaping through scientific literacy. The data collection techniques in this study consisted of a questionnaire. Through the data collection, the instruments needed in this research include validation sheets of material experts and media experts. The data were analyzed quantitatively to determine the category of validity and deepened by qualitative analysis. Based on the results of expert validation, research-based teaching supplements regarding the dangers of vaping were generally very valid with the average validation score of the two validators being 94.45%. The material contained in the teaching supplement was also adapted to current scientific developments related to the dangers of vaping by following scientific literacy indicators. The effectiveness of teaching supplements was determined based on the N-Gain value. The value of N-Gain obtained was 0.76 that mean in the high category.

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## INTRODUCTION

One of the keys in facing the challenges of the 21st century is scientific literacy, namely the ability of individuals to understand and apply scientific concepts in real life. Scientific literacy nowadays can be a guide that must be owned by every individual both in everyday life and in the world of work. Individuals who are scientifically literate can utilize the scientific information they have to solve problems in everyday life (Kimianti & Prasetyo, 2019).

But lately, many teenagers who were students had low scientific literacy, namely the lack of utilization of scientific information which is characterized by low knowledge about the dangers of e-cigarettes or vaping, which based on interviews showed that 70% of randomly selected students did not know the content and the dangers of vaping. They also considered that vaping safer when compared to conventional cigarettes. They did not know about the harmful ingredients of vaping. In addition, based on the results of interviews in several vaping stores, it turned out that many high school students used vaping, according to the guards in each vape store, there were about 4-5 high school students who became customers at the vaping store. This is in line with the research of Istiqomah et al. (2016), which states that teenagers are starting to switch to use vaping on the grounds that vaping is considered lighter than conventional cigarettes. In addition, there is a lack of knowledge of students about the harmful content of vaping and its impact on health. This shows the low level of awareness of the dangers of vaping. For now, research on the impact of vaping is being studied to find out how much damage to systems in the human body caused by vaping, one of which is on the respiratory system.

There is a Core Competency regarding the respiratory system In the Core Competencies analysis for Biology lessons at the high school level, namely Core Competency 3.8. Analyzing the relationship between the structure of the tissues making up organs in the respiratory system in relation to bioprocesses and functional disorders that can occur in the human respiratory system and Core Competency 4.8 Presenting the results of the analysis of the effects of air pollution against abnormalities in the structure and function of human respiratory organs based on literature

studies. However, based on the results of interviews, teachers only used teaching materials to support the biology learning process, one of which is the respiratory system material. The teaching materials currently used based on the results of observations only used teaching materials sourced from the government, namely textbooks. The material in the teaching materials is considered to be incomplete and not deep so there was a need for teaching supplements that presented the latest information that could improve students' scientific literacy.

A research conducted by (Haryadi et al., 2017), states that one of the advantages of teaching supplements is that it can hone students' awareness. In addition, (Lukito et al., 2015), states that in science learning it is necessary to have a supplementary book that balances aspects of scientific literacy so that students will find it easier to interpret learning. This supplementary book is complementary to the shortcomings of existing textbooks, particularly in relation to the dimension of scientific literacy.

In the research of (Putra et al., 2019), which is a study of the effect of exposure to e-cigarette smoke compared to exposure to conventional cigarette smoke on the lung histopathological figure of male mice, it was found that the damage to the lung histopathological structure of mice caused by vaping smoke and conventional cigarette smoke was the same dangerous and cause significant damage. In addition, according to (Gotts *et al.*, 2019), also states that there has been no research in which the research was able to prove that vaping is safer than conventional cigarettes. Like smokers, vapers also tend to have varying susceptibility to lung damage. Vaping and conventional cigarettes have a similar pattern of particle deposition in the lungs, and nicotine is rapidly absorbed and delivered to the brain (Thirion-Romero et al., 2019). According to Bonner et al. (2021), e-liquids in e-cigarettes can contain high concentrations of nicotine which can be toxic to children and adults if inhaled, through the skin or ingested. Jankowski et al. (2019) state that vaping use among adolescents was shown to result in higher levels of nicotine dependence than nicotine dependence associated with conventional cigarette use.

Several research results regarding the dangers of vaping can be used as a modern medium to convey new information that will be made in the

form of research-based teaching supplements. In previous development research, there has been the development of a teaching supplement book for respiratory system materials that was developed to improve students' understanding and attitudes towards cigarettes (Elisa, 2019). However, there have been no developments that lead specifically to the presentation of information about the dangers of vaping based on research results for increasing scientific literacy. Therefore, it is necessary to innovate learning resources that are able to improve scientific literacy, namely by utilizing research results in the form of applicable information in everyday life, one of which is about the dangers of vaping so as to be able to provide the latest information to students as learning resources that will be packaged in form of teaching supplement with the title "When Vape Means Fire". The purpose of this study was to determine the validity of the teaching supplement based on the results of the research developed.

## METHOD

The development of teaching supplements based on research results regarding the dangers of vaping is designed with a Research and Development design that refers to the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) (Aldoobie, 2015). The data collection techniques in this study consisted of a questionnaire. Based on the data collection, the instruments needed in this study include validation sheets of material experts and media experts. The data were analyzed quantitatively to determine the category of validity and deepened with a qualitative analysis of the strengths and weaknesses of the book. One-Group Pretest-Posttest Design research was used. The sample in this study was 60 students of class IX. The sampling used purposive sampling technique, with the help of the biology teacher.

## RESULTS AND DISCUSSION

The teaching supplements developed have an actual characteristic that contain the latest facts based on trusted articles about vaping, the content of vaping, and the dangers of vaping. In addition, the

teaching supplement developed contains the latest research results regarding the dangers of vaping. The teaching supplement that was developed also contains questions in the "Let's Write" column, which questions refer to scientific literacy indicators. The preparation of the teaching supplement design that was developed starting from a needs analysis regarding teaching materials for respiratory system disorders, then designing the main content of the teaching supplement in which the main content design of the teaching supplement consisted of a cover with the title When Vape Means Fire, Acknowledgement, Table of Contents, List of Figures, , List of Tables, Introduction, Vaping Danger and Nicotine Content, Research Results on Vaping Danger, Vaping Effects, Glossary, Bibliography and About the Author. The teaching supplement will contain information that can support the learning process of respiratory system disorders.

Furthermore, a literature study was conducted from various books and articles about vaping, its contents, and its dangers. In addition, the authors also read the results of research on the dangers of vaping, most of which had been tested on the dangers of vaping on mice. After doing a literature study, then the author hunting for personal documentation was carried out at the nearest vape store. Several photos were taken to complete the illustration of the developed teaching supplement. For example, photos of various vaping products, various vaping liquids, photos of people who were vaping, and photos of illustrations of people affected by brain disorders due to vaping. Photos that were difficult to personally document can be searched on the internet by always citing the source. Then the product development was carried out. The product was developed by using a design application, namely CorelDRAW X7. After the product was finished, the validity of the product was analyzed.

The validity of the teaching supplement consists of the validity of the material and the validity of the media. This validity aims to determine the level of validity of the teaching supplements that had been developed. To test the validity of the product that had been developed, it was carried out by material experts and media experts. The results of the assessment by material experts are presented in table 1.

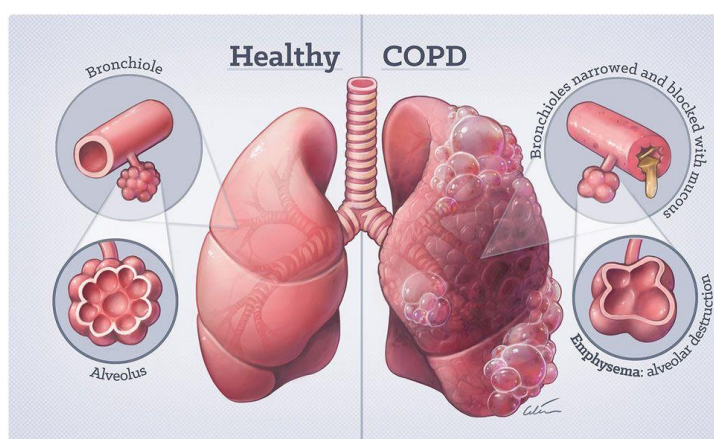
**Table 1.** Assessment Results of Material Expert

Assessment Aspect	Indicator	Number of Score (%)		Average
		items		
Material	Material suitability	1	75	84.7
	Material accuracy	4	87.5	
	Learning support materials	3	91.7	
Language	Suitability with the level of students understanding	1	100	96.9
	Communicative	2	100	
	Suitability with the correct Indonesian	2	87.5	
	The use of terms	2	100	

The validity obtained from the assessment of material experts reached a score above 75%, with an average score of 92% which was included in the very valid category. The language aspect got a score percentage of 96.9% which was included in the very valid or feasible category. This is in line with Maulita's research, (2015), which explains that the quality of the language used is proportional to the quality of the teaching materials because the text is the basic aspect of the content in a science teaching material. In preparing teaching supplements, language is an important component. Innovation of teaching materials that facilitate students' understanding is by using simple and familiar words but does not rule out the true meaning (Kurniasari *et al.*, 2014). In the material aspect, namely the material suitability indicator, the lowest score

percentage was 75%, this could be caused because on the material completeness indicator there was only one statement item and a score of 3 is obtained, this is due to the need for material that must be added, namely regarding COPD according to material expert suggestions.

The material expert conveyed several suggestions including the need for additional illustrations of the condition of healthy lungs as well as lungs with COPD, as said by (Kustandi & Sutjipto, 2013), images as graphic media have the aim of attracting attention, clarifying material, illustrating facts and information that was faster if illustrated with figures. So that an illustration of the condition of healthy lungs was added as well as lungs with COPD.

**Figure 1.** The illustration of the condition of healthy lungs as well as lungs with COPD

In addition, there were other suggestions from material experts, namely that it needed a little discussion about COPD, then "COPD or Chronic Obstructive Pulmonary Disease which in Indonesia is

commonly called as *Chronic Obstructive Pulmonary Disease (COPD)*, referring to a group of diseases that cause airflow obstruction and breathing-related problems. Diseases that include COPD are emphysema and chronic

bronchitis (CDC, 2021). Emphysema usually refers to the destruction of the tiny air sacs at the ends of the airways in the lungs was added. Chronic bronchitis refers to a chronic cough with the production of phlegm due to inflammation in the airways. Reducing exposure to tobacco smoke is important for COPD primary prevention and disease management (WHO, 2022).” and there is a narrative that still needed to be edited, namely there is a paragraph with the similar words on page 16, “Using nicotine in adolescence can harm the parts of the brain that control attention, learning, mood, and impulse

control. Each time a new memory is created or a new skill is learned, stronger connections (synapses) are built between brain cells. Young brains build synapses faster than adult brains. Nicotine changes the way these synapses are formed. Using nicotine in adolescence may also increase the risk of future addiction to other drugs (CDC, 2022) for example, cocaine.” so one of paragraphs was deleted.

Furthermore, the results of the assessment by media experts are presented in table 2

**Table 2.** Assessment Results of Media Expert

Assessment Aspect	Indicator	Number of Items	Score (%)	Average
Display Performance	Media quality	8	93.8	93.8
Benefit Performance	Usefulness in media use	2	100	100

The validity obtained from the assessment of media experts reached a score above 75%, with an average score of 96.9% which was included in the very valid category. The media quality indicator showed a lower percentage of the score compared to the usefulness in using media, this was because in statements number 5 and number 6, namely the accuracy of the color of the text with the background used and also the quality of the image used to support the display only got a score of 3 because the image used a face image of someone who was not a personal model according to media expert suggestion. Media experts conveyed several suggestions, including the *Kata Pengantar* to replace the *Prakata* (Foreword), the figures taken from the internet or e-books should mention the source or link, figures that describe a person's face should be replaced with a personal model or facial figure removed and replaced with other illustrations. So that a follow-up was carried out according to the suggestion of media experts.

In the teaching supplement that had been developed there were several pictures and tables to facilitate student understanding. According to (Prastowo, 2014), a good textbook should meet the requirements of appropriate presentation components, namely tables and pictures to support the presentation of material so that students' thinking skills became more easily stimulated. If in the validity test there were deficiencies or revisions,

then the media needed to be refined in accordance with the advice of the validator, both material experts and media experts. Based on the good results of the validity of the material and media, the validity was obtained with a very valid category. However, improvements still needed to be made both in the media aspect and in the material aspect in order to obtain credibility from even valid media (Ihsan, 2015). So, the results of the average validity of material experts and media experts obtained a percentage score of 94.45 which was included in the Very Valid category.

This teaching supplement was supported by content that functioned to empower students' scientific literacy regarding the dangers of vaping. The content included presenting information on the dangers of vaping that was integrated into research results and there was a “let's write” column which contains questions that refer to scientific literacy indicators. In general, the teaching supplements that had been developed implemented scientific literacy, particularly regarding the dangers of vaping which directs students to understand information about the dangers of vaping as a capital in preventing diseases that attack the respiratory system.

The effectiveness of the teaching supplement was determined based on the N-Gain value and the percentage result of the Vape Hazard Attitude Care Scale. Learning outcomes in the cognitive aspects of students were determined by the scores of the pre-

action cognitive test (pre-test) and post-test (post-test) by using the When Vape Means Fire teaching supplement which referred to a grid of scientific literacy questions. The result was an increase in the value of learning outcomes. Pre-action cognitive tests (pre-test) were carried out before students were given action to determine the initial abilities of students before being given action, namely learning to use teaching supplements of When Vape Means Fire.

The use of When Vape Means Fire teaching supplement media in learning made students more active. Students were directly involved in the discussion process in learning. Understanding of the material discussed could be more easily absorbed by students so that there was an increase in post-test scores. Based on the results of the post-test, an increase in score was obtained with an average of 87.75. The recapitulation of student learning outcomes can be seen in the table below.

**Table 3.** Recapitulation of Student Learning Outcomes

No	Variable	Score		N-gain	
		Pre-test	Post-test	Score	Category
1	Minimum	40	75		
2	Maximum	70	100		
3	Average	48.75	87.75	0.76	High

The average N-Gain test obtained was 0.76 where the N-Gain obtained was in the High category. So, it can be concluded that there was an increase in learning outcomes in this case, referring to the scientific literacy aspect of 60 class XI students of SMA Negeri 1 Bumiayu before and after used the When Vape Means Fire teaching supplement. This is in line with the research of (Kurniawan et al., 2020), which suggests that student book supplements have a great influence on learning outcomes, a big influence in this case is a positive influence for students.

## CONCLUSION

Based on the results of expert validation, research-based teaching supplements regarding the dangers of vaping were generally very valid with the average validation score of the two validators being 94.45%. The material contained in the teaching supplement was also adapted to current scientific developments, of course, related to the dangers of vaping by following scientific literacy indicators. The effectiveness of the teaching supplement was determined based on the N-Gain value the N-Gain value obtained is 0.76 which is in the High category. It is hoped that the developed teaching supplement will be very useful and supportive in learning biology, particularly relevant materials namely respiratory system disorders, which can also improve students' scientific literacy. The validity of the book had been supported from the aspect of

material, appearance, language and usability which was revised in such a way after validation.

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