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Development of Physics E-book based on Socio Scientific Issues Assisted by Heyzine Flipbook on Static Fluid Topic to Improve Students' Critical Thinking and Collaboration Skills

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Abstract: Integrating Socio Scientific Issues (SSI) in physics learning encourage students to actively discuss a problem, understand the nature of science, consider the controversies and their influence on the world both physically and socially. This research aims to produce an e-book on Static Fluid topic based on SSI assisted by Heyzine Flipbook, which is suitable for use to improve students' critical thinking and collaboration skills and determining its effectiveness. This method used in this study is research and development (R&D) with the define, design, develop, and disseminate (4D) model. The define stage aims to determine what is needed in the e-book development. The design stage is designing the e-book based on a certain format. The develop stage involves making the products, namely the e-book and instruments. The disseminate stage involves widespread distribution of the e-book that has been developed. The research result shows that the e-book based on SSI assisted by Heyzine Flipbook is valid based on the evaluation of physics experts and teachers, as well stated valid with very good category by the students' responses. The e-book helps students to increase their abilities to think critically and collaborate in the classroom.

Keywords: Collaboration skill; Critical thinking ability; E-book; Heyzine flipbook; Socio scientific issues; Static fluid.

Introduction

Nowadays, education is one of the supporting factors for a person's success. Entering the 21st century is marked by very significant changes in the world of technology, information, communication, economy, health, and also in the world of education. Schools as educational institutions have a curriculum and learning design that play a very important role in producing the next generation with educational experiences that are able to survive and navigate the rapid flow of globalization. Therefore, educational institutions should equip prospective future generations with 21st century skills.

Moreover, the world is experiencing the fourth industrial revolution, also known as the 4.0 industrial revolution of the 21st century global era where information technology is very important for human life today. That is why the education sector has to adapt to this current situation, including physics learning. The demands for physics learning skills in the 21st century global era consist of four components, namely: critical thinking and problem-solving skills, communication skills, collaboration, and creativity and innovation (Azmi et al., 2024; Dishon & Gilead, 2021).

Physics subjects in high school study everything about the nature, matter, motion, energy, and phenomena in the universe that involve skills and

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reasoning. Physics is a branch of natural science that studies phenomena occurring in nature. The process of forming conceptual understanding in physics is carried out through observation, discovery, data presentation, drawing conclusions systematically, and based on certain scientific principles. However, physics is one of the science subjects that is considered difficult by students because physics is abstract and complex. Physics requires extra thought to be able to understand and learn it (Istyowati et al., 2017). Students have difficulty understanding the concept of physics because there are too many formulas, hence it is difficult to work on questions and it is not interesting (Fidan & Tuncel, 2019).

Meanwhile, physics learning has the goal of developing students' knowledge, understanding, and analytical skills towards their surrounding environment (Bao & Koenig, 2019). Physics learning for students is expected not only to master concepts but also to apply the concepts they have understood in solving physics problems. Physics learning in the global era of the 21st century promises to enable students to live a social life supported by skills learned in the classroom (Siswanto, 2020; Winarti, 2020). In physics learning, students are required to understand the concepts that occur in nature. Students are involved in the process of building models that help them understand the relationships and differences between physics concepts.

In the 21st century, education in life skills is increasingly important to support students to have skills in the field of technology and information media, learning, creating, and innovating (Wijaya et al., 2016). Students are required to have a skills covering the fields of knowledge, media technology, and information in the learning process (Donovan et al., 2014). Other abilities such as problem solving, collaboration, critical thinking, and mastering concepts are the most important competencies in entering the 21st century life (Kurniahtunnisa et al., 2023; Novia et al., 2024).

The learning process of the 2013 Curriculum emphasizes students to be able to observe, ask questions, reason, communicate, and present the results they get after participating in learning at school (Anwar, 2014). The implementation of the 2013 Curriculum learning directs students to be more active and motivated in the learning process, so that attitudes of curiosity, independence and self-confidence can be seen in the learning process.

Critical thinking skill is the ability to analyze the learning process and conclude the results. Critical thinking is an activity that involves the ability to make decisions and is part of high-level thinking skills (Susilo et al., 2020). The critical thinking skill greatly helps students in solving more complex problems (Mundilarto & Ismoyo, n.d.). Critical thinking skills can also help students' reasoning to solve problems. Students' critical thinking skills can be improved by using active learning and using learning models or learning media that motivate students when finding solutions to problems (Redhana, 2019). Thus, teachers play an important role in improving students' critical thinking skills with the right approach and learning media.

Students with critical thinking skills can make decisions and find solutions to problems in the school, personal life, and the environment (Syarifah & Sumardi, 2015). However, in a study by Susilawati et al. (2015) it was found that students have low critical thinking skills. Currently, the cognitive abilities of Indonesian students are still relatively low and have not yet moved towards critical thinking skills. Furthermore, it was obtained that the average critical thinking of students is at an intermediate level. This is similar to a study by Purwati et al. (2016) where around 32.2% of students have low critical thinking skills and 42.8% of students is in the moderate category. In addition, several studies have shown low critical thinking skills of students. The percentages of critical thinking skills in the indicators of providing explanations, concluding, and building basic skills, which are in the low category are 50%, 72%, and 65%, respectively (Dharmayanti et al., 2022). Critical thinking skills of students in the indicators of self-regulation, explanation, inference, analysis, and interpretation produce percentages of 48.29%, 9.68%, 41.94%, 58.06%, and 38.71%, respectively (Benyamin et al., 2021). Moreover, according to Afriana et al. (2021) the overall critical thinking skills of students in solving higher order thinking skills (HOTS) type national exam questions were still in the medium category with low categories of concluding, explanation, and setting strategy indicators.

Collaboration is also a skill that has to be mastered by students. Collaboration can be understood as working together to achieve a certain goal. This skill can be in the form of students working together in groups. That is why, several aspects of collaboration skill include communication, team responsibility, mutual respect, assessment, and holistic intervention (Dewi et al., 2024). Collaborative learning leads to the development of metacognition, improvement in formulating ideas and discussions (Nadia et al., 2024). Moreover, collaboration-based learning can be seen as dividing students into (small) groups to solve a problem and/or achieving a goal (Hidayati & Sugiharto, 2022).

In general, most teaching materials are in the form of printed books that are usually read and also function as evaluation tools. Meanwhile, in the current era, students tend to rely on electronic media to obtain information. Therefore, a form of teaching materials that is in line with the current situation is electronic books (e-books). E-books are a digital form of printed books that

contain knowledge, in terms of language, content, and extensive discussion (Sukatin et al., 2023). E-books consist of text, images, videos or audio in a digital form so that students can access them online or offline via computers or other electronic devices such as tablets, smartphones and Androids (Mentari et al., 2018). E-books themselves have advantages in that they are easy and practical to carry, durable, environmentally friendly, and easier to distribute. Several studies on the use of e-books have revealed that e-books provide many positive benefits for both students and teachers. In fact, the use of e-books and/or e-modules can help improve students' critical reasoning (Adhelacahya et al., 2023; Cynthia et al., 2023; Hasanah et al., 2016). Furthermore, the e-book can be developed with the help of Heyzine flipbook, which contains images, sound, video, and navigation, making it more interactive. Using Heyzine flipbook makes learning more interactive. An advantage of Heyzine flipbook is that it is not boring as it contains video, audio, text, or images that support the context of the e-book (Anggreni & Sari, 2022).

Socio Scientific Issue (SSI) is a learning approach that raises social issues related to science in learning activities (Badeo & Duque, 2022). According to Faishol et al. (2021) the use of SSI is considered very appropriate because social issues are directly related to students' daily lives. The topics presented in learning must be up-to-date and controversial issues that are developing and/or close to students' lives and interesting to discuss (Lubis et al., 2022). Moreover, SSI can be applied using various learning methods, e.g.: project-based, problem-based, and group investigation learning methods (Dusturia et al., 2024). A previous study has been conducted on developing an e-module based on SSI to improve critical thinking and environmental care skills on green chemistry using Fliphtml5 application (Rasyih et al., 2024).

Problems faced by students in the learning process are usually caused by short temporal understanding or knowledge. This is because students are accustomed to memorizing materials or equations obtained in the learning process. Students who tend to be less active are caused by not having enough opportunities to discover the physics concepts they are studying. Students are more accustomed to directly receiving ready-made knowledge delivered by teachers. Students seem to be accustomed to receiving information rather than seeking information. This is the reason why this study is essential to be conducted. The SSI can be presented in the form of e-books, which can be accessed anytime and anywhere. Moreover, because of the nature of the e-book that can be accessed online, the learning process may be conducted online as well. Students do not need to bring printed book; they can just open their smartphone and all information is available on the Internet. Hence, students are easier to study physics concepts in order to tackle the above problems.

Method

This study used the research and development (R&D) method. In this study, the product produced was a physics e-book based on SSI assisted by Heyzine flipbook on Static Fluid topic in improving students' critical thinking and collaboration skills. The development of this physics e-book can be explained as follows (see Figure 1). At the define stage, four analyses were carried out, namely initial analysis, student analysis, concept analysis, and test analysis. These analyses were used to define the need of students and then implemented in the development of the e-book.

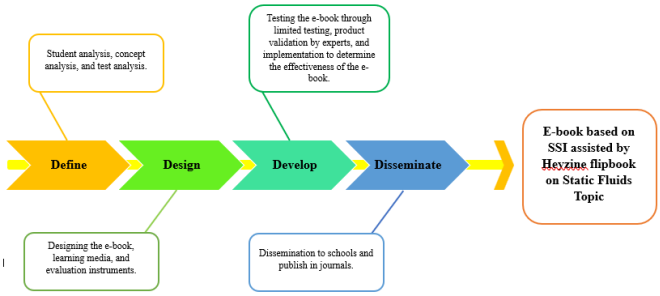

Figure 1. the development procedure used in this study.

The design stage consisted of activities to design the e-book. The researcher designed the learning media and evaluation instruments. This design form was based on the 2013 Curriculum. The instruments were developed to evaluate critical thinking and collaboration skills of students after using the e-book. The media used was an Android application that was operated via a website link. The development of SSI-based e-book assisted by Heyzine flipbook was carried out using Microsoft Word and Canva. The e-book was created based on the components contained in the e-book matrix.

At the product validation stage, experts assessed the feasibility of the product being developed. The product feasibility assessment validation sheet was given to the validators consisting of lecturers and teachers. After the experts provided the feasibility assessment of the product, revision was made to the product being developed. The product validation was conducted to obtain effective and better e-book that can be used in the study. The validated and revised product was then tested in a limited and field trials. Limited and field trials were carried out to determine the effectiveness of the product.

Finally, the disseminate stage was carried out. The results of the field trial may be improved if there were revision suggestions from students and teachers.

Furthermore, the final developed product was given to teachers for dissemination in schools.

The empirical test was conducted on 200 students at SMA N 9 Yogyakarta and SMA N 1 Depok. The limited and field trials were conducted at SMA Negeri 1 Depok. The limited test utilized a sample of 30 students. The field trial consisted of the experimental, control 1, and control 2 classes, each of which consisted of 36 students. The field trial was conducted in class XI Science.

The data collection techniques include test and non-test instruments. Test instruments include pretest and posttest questions on students' critical thinking skills. Non-test instruments include student collaboration skills questionnaires, instrument validation sheets, e-book reliability sheets, and student response questionnaires. The test instrument validation sheet was given to two physics lecturers and three physics teachers. The lesson plan assessment sheet was used to determine the feasibility of the lesson plan during the study. The feasibility was assessed by expert validators. The media assessment sheet was used to assess the feasibility of the product. This assessment was carried out by media and material experts. The critical thinking test consisted of pre-test and post-test. The test was in the form of essay questions. Questions were developed based on indicators of critical thinking skills. A questionnaire was used to determine students' collaboration skills using 20 questions. This assessment instrument used a Likert scale. The assessment was carried out with four assessment scale criteria, namely strongly agree, agree, disagree, and strongly disagree. The content observation instrument was used to determine students' collaboration skills. Observers observed activities carried out by students. The student answer sheets help determine students' reactions to the learning media developed. This sheet was intended to determine the readability of the e-book used by students.

Data analysis was conducted through the assessment validation sheet by several validation experts using the Aiken V test. Validity decisions are made in comparing the calculated Aiken V value to the formulated Aiken V table and in accordance with the number of existing raters (Retnawati, 2016). The product feasibility assessment was conducted by students using the student response questionnaire. The assessment was conducted using a Likert scale with 4 categories, namely strongly agree (4), agree (3), disagree (2), and strongly disagree (1). The data were then classified into an actual score stating the level of feasibility of the product being developed. The analysis of the empirical testing results of the test instruments was carried out by analyzing the validity and reliability of the test instruments being tested. The test instruments used in the data collection must be able to measure what will be measured (validity) and have a good level of reliability or it is said that the instruments must be valid and reliable so that the data obtained were good. Validity and reliability were analyzed using the QUEST application. Collaboration skill data analysis (observer and questionnaire data) was conducted with the following steps. Tabulation of observer and questionnaire scores obtained from students. The scores of each observer and questionnaire results were calculated as an average score. The average score of observation and questionnaire score was calculated as a collaboration skill score.

The MANOVA statistical test was conducted to analyze the data on students' critical thinking and collaboration skills. There were several requirements that must be met before conducting the MANOVA test. This stage was conducted to determine the effectiveness of the product in improving students' critical thinking and collaboration skills in physics learning. This effectiveness was determined through statistical tests. The analysis was conducted using SPSS 25. At this stage, the category score test of two groups or two groups MANOVA was conducted to determine the differences in the improvement of students' critical thinking and collaboration skills. MANOVA test has more than one number of variables. In this study, the data used for multivariate normality test were critical thinking and collaboration skills values from three classes, namely experiment, control 1, and control 2.

Before the MANOVA test was carried out, prerequisite tests were conducted first. Some of these prerequisite tests were explained as follows. The normality test was used to assess whether the sample was normal or not. Next, the homogeneity test aimed to determine whether two groups were homogeneous or not. The significant level guideline was used to determine homogeneity, i.e.: $\alpha = 0.05$. If Sig. > α was obtained, then the two groups were homogeneity, otherwise the groups were not homogeneous because the variance of each sample was not the same.

Finally, the effect size test was carried out to determine how much influence the learning using the product made. This analysis was carried out in two stages, namely the analysis stage to determine the effect of learning using the physics e-books based on SSI assisted by Heyzine flipbook simultaneously on the variables of critical thinking and student collaboration skills. Then the second stage was conducted using the results of the pre-test and post-test analysis in each class.

Results and Discussion

The product developed in this study is a physics e-book based on SSI assisted by Heyzine flipbook. The

development is based on the 4-D development model consisting of four stages, namely: define, design, develop, and disseminate. The developed product was assessed by validators consisting of 2 lecturers and 3 physics teachers. The validators provided suggestions and input, which the developed product was revised (first revision).

The limited trial process was carried out after validation process and the product was declared fit for use according to experts. In the limited trial, the revised product II was obtained. This revised product II was used in the field test so that the final product was ready to be distributed. The final product obtained in this study, namely the e-book based on SSI assisted by Heyzine flipbook on Static Fluid topic can improve critical thinking and collaboration skills of students. An illustration of the e-book may be observed in Figure 2.

The research design used was a pretest-posttest control group where there was one experimental class and two control classes. The experimental class used an e-book based on SSI assisted by Heyzine flipbook on Static Fluid topic. Students were formed into several small groups and then followed learning using an e-book based on SSI assisted by Heyzine flipbook. The first control class used SSI based learning on Static Fluid topic. Students were formed into several small groups and then conducted the learning using SSI. Meanwhile, the second control class used the learning method by physics teachers at SMA Negeri 1 Depok Sleman.

The final product of the physics e-book based on SSI assisted by Heyzine flipbook on Static Fluid topic can improve critical thinking skills of students. This is in accordance with a study by Febriani & Dwandaru (2022) that SSI in physics learning can help students practice critical thinking skills The advantages of the e-book developed are the learning activities that are arranged based on SSI that are often encountered by students in everyday life; the e-book is portable; and the e-book is interesting to read because it uses an attractive design that can make students interested and happy to learn. These advantages are expected to improve the learning achievement of students (Ma et al., 2023).

This physics e-book based on SSI assisted by Heyzine flipbook is developed by collaborating physics education, SSI around students, and technology. The selection of SSI in the material of Hydrostatic Pressure was carried out by analyzing the physics material in the event.

The e-book based on SSI assisted by Heyzine flipbook is expected to be able to act as a media that supports the physics learning process in schools so that it can improve students' critical thinking and collaboration skills. This e-book uses the Heyzine flipbook software so that it is easy to access via students' smartphones. Smartphones are considered appropriate to be used as a tool to convey learning content because students and teachers are familiar with smartphones that are commonly used in everyday life (Iqbal & Bhatti, 2020).

The developed e-book has the following characteristics. The e-book based on SSI assisted by Heyzine flipbook runs via smartphone. The e-book based on SSI assisted by Heyzine flipbook consists of the main material, apperception, sample questions, practice questions, student worksheet, and a summary that is integrated into the Static Fluid topic. This is in accordance to a previous study conducted by Baihaqi et al. (2024) where an e-book on the topics of Diffraction and Polarization has been produced. Finally, the developed e-book can improve critical thinking and collaboration skills of students.

The MANOVA test is obtained from the analysis of the field trial using IBM SPSS Statistics 26. The results of the MANOVA test are based on the Hotelling's trace formula. The analysis of the MANOVA test can be seen in Table 1.

Effect Size test is obtained from the analysis of the field trial using IBM SPSS Statistics 26. The results of the effect size test are based on the effect size formula on the eta square value. The effect size test analysis can be seen in the Table 2**.**

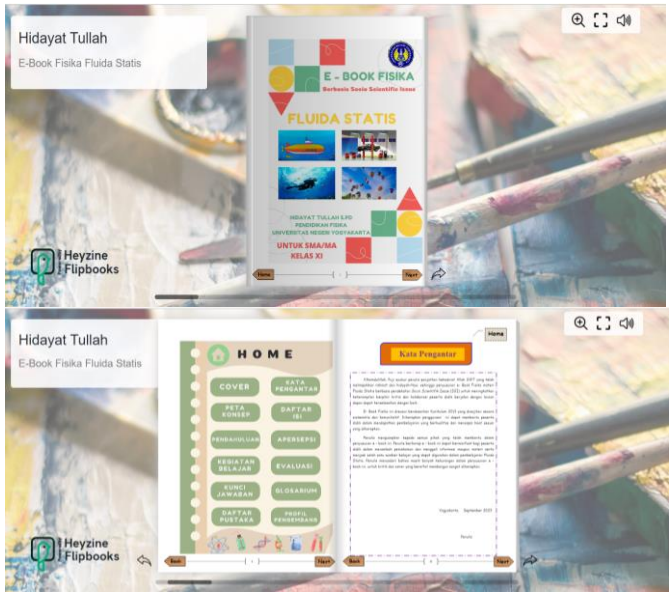

Figure 2. Physics e-book view on Heyzine flipbook.

Table 1. Multivariate Tests

Effect		Value	Sig.	Partial eta squared
Intercept	Pillai's Trace	0.99	0.000	0.99
	Wilks' Lambda	0.001	0.000	0.99
	Hotelling's Trace	902.85	0.000	0.99
	Roy's Largest Root	902.85	0.000	0.99

Table 2. Tests of Between-Subjects Effects

Variables	Class	F	Sig.	Partial eta squared
Critical Thinking	Control 1	0.60	0.55	0.01
	Control 2	1678.91	0.00	0.94
	Experiment	6458.13	0.00	0.98
Collaboration	Control 1	1.56	0.22	0.03
	Control 2	39590.68	0.00	0.99
	Experiment	47124.04	0.00	0.99

Conclusion

The e-book based on SSI assisted by Heyzine flipbook can improve critical thinking and collaboration skills of students on the topic of Static Fluid material. The feasibility of the e-book based on SSI assisted by Heyzine flipbook may improve critical thinking and collaboration skills of students on Static Fluid topic. The validation results of the e-book based is in the very good category, which indicates that e-book is suitable for use in the physics learning process in the classroom. Based on the field trial, the produced e-book is in the good, valid, and reliable category, which shows that the learning media is suitable for use in the physics learning process in the classroom. The e-book is effective in improving the critical thinking skills of students as seen from the Cohen's F value with the interpretation of large effect size.

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Author Contributions

Conceptualization, H. T., W. S. B. D.; methodology, H. T., A. A.; validation, H. T., formal analysis, H. T., A. A.; investigation H. T.; resources, H. T., W. S. B. D.; data curation, H. T., A. A.; writing – original draft preparation, H. T., W. S. B. D.; writing – review and editing, H. T., A. A., W. S. B. D.; visualization, H. T. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interests regarding this manuscript.

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