

Effectiveness of Thermodynamics Textbooks Assisted by Heyzine Flipbook to Improve Students' Generic Science, Critical Thinking and Conceptual Understanding

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Abstract: Thermodynamics as a science studie something concrete and can be proven mathematically using scientific equations that have been proven to be true, so it is not uncommon for students to think that it is difficult to understand. This is because a high level of understanding is needed to understand the concepts of thermodynamics. The aim of this research is to develop a thermodynamics textbook assisted by Heyzine flipbook which is effective in improving students' generic science, critical thinking and conceptual understanding. This research is a development researchs (Research and Development) which uses the Thiagarajan 4D development model. The subjects in this study were 26 students of the Physics Education study program at Mataram University who took the thermodynamics course. The data in this study is in the form of product effectiveness data obtained through pre-tests and post-tests given to research subjects. The improvement in students' abilities calculated using the n-gain formula. There was an increase in student abilities after being taught with the thermodynamics textbook assisted by Heyzine flipbook according to the n-gain value of 53.31 with moderate criteria. Heyzine flipbook-assisted thermodynamics textbook is proven effective in improving students' generic science, critical thinking and conceptual understanding.

Keywords: Conceptual understanding; Critical thinking; Effectiveness; Heyzine flipbook; Generic science

Introduction

The development of the era in the 21st century has caused many significant changes to various sectors. The 21st century is synonymous with technology, thanks to technological advances, education has undergone a significant transformation (Grassini, 2023; Wang et al., 2024). Technology is expected to bring good progress in the field of education, becoming a smart and optimal choice in the distribution of learning materials and concepts (Dimitriadou & Lanitis, 2023; Kamalov et al., 2023). Utilizing technology in the field of education will encourage students to obtain, analyze, manage, and apply knowledge and information (Kamza et al., 2023).

Seeing the increasingly advanced development of the era, there needs to be new innovations in the world of education to improve the quality of education (Salsabila et al., 2021). These new innovations can be poured into learning, one of the learning that can be used as a means is science learning.

Thermodynamics is one of the subjects in science that is commonly studied but is considered difficult to understand. Abstract concepts such as entropy, enthalpy, free energy, state functions, reversibility and cycles make it increasingly unclear and difficult to understand (Wu & Wu, 2020). Thermodynamics as a science study something concrete and can be proven mathematically using scientific equations that have been

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proven to be true, so it is not uncommon for students to think that it is difficult to understand. This is because a high level of understanding is needed to understand the concepts of thermodynamics (Sutarja & Wulandari, 2021). High conceptual understanding does not suddenly grow in students, but the ability to understand concepts needs to be trained and developed. If students already have a good understanding of concepts, critical thinking skills and generic science will change significantly (Muhfahroyin et al., 2023). Students' understanding of learning will be better if they pay attention to the students' generic science abilities.

Generic science skills play an important role in the formation of scientific knowledge for students that will be used in every aspect of life. This ability can be used to learn concepts and solve science problems. Generic science skills must be possessed by students to be able to think analytically and think at a high level in this case critical thinking (Izetbigovic et al., 2019). 21st century skills need to be trained to deepen knowledge and demonstrate understanding through activities. Students' critical thinking skills show that students have the ability to reason and produce decisions based on scientific facts found. Thinking skills indirectly affect students' conceptual understanding abilities (Syamsinar et al., 2023). By thinking critically, students find it easier to understand concepts and have various ways of solving a problem. Student abilities such as generic science, critical thinking and conceptual understanding can be trained and developed through textbooks that facilitate students to improve these abilities (Darling-Hammond et al., 2020).

One type of textbook that can be used is a textbook that integrates technology (Kempe & Grönlund, 2019; Knight, 2015). Learning by integrating technology and designed as attractively as possible is expected to be able to improve the generic science, critical thinking, and conceptual understanding of prospective teacher students. Consideration of the use of textbooks is one of the important roles of a teacher to find alternatives for students in learning in order to attract students' interest in learning (Bergmark et al., 2018). A textbook that has been designed is expected to be able to create a challenging learning atmosphere that trains students to face problems and be able to think of solutions to the problems faced (Le et al., 2018; Mhlongo et al., 2023).

Textbooks that integrate technology can help create a fun and comfortable learning atmosphere (David & Weinstein, 2024; Haleem et al., 2022). There are many software or websites that can be accessed anytime and anywhere. One website that can be used is Heyzine Flipbooks. Heyzine flipbooks is one of the software that can be used to design and develop textbooks (Putra et al., 2023). This study aims to develop a Heyzine

Flipbooks-assisted textbook that is effective in improving generic science skills, critical thinking, and critical thinking in students.

Method

This research is a research and development which uses the Thiagarajan 4D development model (Aldi et al., 2022). The subjects in this study were 26 students of the Physics Education study program at Mataram University who took the thermodynamics course. The data in this study is in the form of product effectiveness data obtained through pre-tests and post-tests given to research subjects. To see the improvement in students' generic science skills, critical thinking, and conceptual understanding calculated using the n-gain formula, the N-Gain formula is used as follows:

$$N-Gain = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}} \times 100 \% \tag{1}$$

Result and Discussion

The aim of this research is to develop a thermodynamics textbook assisted by Heyzine flipbook which is effective in improving generic science, critical thinking and conceptual understanding. The pre-test and post-test scores and the n-gain scores after the lecture with the developed textbook product are as follows

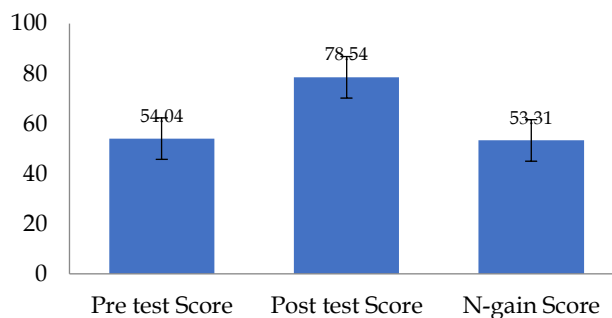


Figure 1. pre-test, post-test and n-gain values

Based on the Figure 1, it is known that there was an increase in student abilities after being taught with the developed textbook according to the n-gain value of 53.31 with moderate criteria. Textbooks are one of the learning resources that are systematically arranged, presenting a complete picture of competencies to be conveyed to students in learning activities that contain explanations of theories, concepts or scientific phenomena (Asikin & Yulita, 2019; Sukarso et al., 2022). Textbooks used in the learning process must be in accordance with the needs of the curriculum and the development of students (Gibson et al., 2023). Along

with the development of the era, currently textbooks are not only in conventional form, but there are electronic textbooks.

This electronic textbook basically has the same characteristics as printed textbooks, the only difference is in the visual presentation format, while the components that make up the textbook do not differ. Electronic textbooks adapt the components found in printed textbooks. The only difference is in the physical presentation of the textbook which requires electronic devices in its use. Textbooks are usually compiled to improve students' abilities so that educational goals are achieved. There are several general student abilities to be trained and developed, namely generic science abilities, critical thinking and conceptual understanding.

Generic science skills are the ability to think and act according to the scientific knowledge possessed, which is closely related to scientific attitudes derived from general science process skills (Ardiansyah et al., 2023). Generic science skills must be possessed by students to be able to think analytically and think at a high level (Ramdani et al., 2021; Widyapuraya et al., 2023). One of the abilities in high-level thinking is critical thinking. Critical thinking is one of the specifications in high-level thinking skills. Critical thinking is related to generic science skills. When students have critical thinking skills, it affects the results of students' generic science skills (Annam & Doyan, 2023; Arifah et al., 2023; Mustapa et al., 2023). Students are said to have understood a concept if they can construct the meaning of learning messages, whether oral, written or graphic through thinking activities. Thinking skills indirectly affect students' conceptual understanding abilities (Solikah et al., 2024). Generic science skills, critical thinking and conceptual understanding can be improved through the preparation of systematic, clear and interesting textbooks (O'Reilly et al., 2022; Ploj Vrtič, 2022; Zulhamdi et al., 2022).

Electronic textbooks are teaching materials with a structured design and packaged using electronic devices digitally in the form of an application or website (Çirakoğlu et al., 2022; Merkle et al., 2022). Electronic textbooks can be accessed via electronic devices such as computers, smartphones, tablets or PCs. Electronic textbooks have several advantages that can make it easier for students. In electronic textbooks, there are interactive images, sounds and videos that are presented to attract the attention of students so that they can improve the learning atmosphere (Yanarti et al., 2022). The use of electronic textbooks makes it easier for students to understand or repeat learning with the aim of gaining clarity and providing opportunities for students to learn independently (Logan et al., 2021). The

advantages of this textbook are what can improve students' abilities.

As technology advances, there are many digital media that can be used in learning such as Socrative, Mentimeter, and Flipbooks. Flipbooks can be compiled from various software, such as Kvisoft Flipbook Maker, Flip PDF Professional, or Heyzine Flipbook Maker. Flipbooks are digital-based media that are in great demand by the public because they have features that provide a different learning experience (Pratiwi et al., 2023). Heyzine flipbook maker is one of the websites that can be used to create electronic textbooks. In addition to easy access, heyzine flipbooks have many features that will make the appearance of textbooks more attractive and improve students' abilities (Dewi & Setyasto, 2024).

Conclusion

Heyzine flipbook-assisted thermodynamics textbook is proven effective in improving students' generic science, critical thinking and conceptual understanding. There was an increase in student abilities after being taught with the Heyzine flipbook-assisted thermodynamics textbook according to the n-gain value of 53.31 with moderate criteria.

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Author Contributions

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

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Conflicts of Interest

No conflict interest.

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