



## The Use of 3D-Based E-Handout on Excretory System Material To Improve Students' Critical Thinking Skills

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### ABSTRACT

Students' critical thinking skills in high school are still lacking. Learning media in textbooks is still less effective and interactive in the learning process. This study aims to analyze the improvement of students' critical thinking skills using 3D-based e-handout. This research is true-experiment research with a pretest-posttest control group design. The population in this study were all eleventh-grade Mathematics and Science major (MIPA) classes at SMAN 1 Ciwaringin, which consisted of 128 students. The samples were classes XI MIPA 1 and XI MIPA 2. This study showed a significant increase in students' critical thinking skills between experimental classes, with an average N-gain value of 0.60 (moderate category), and the control class, with an N-gain value of 0.28 (low category).

#### ***Penggunaan E-Handout berbasis 3D pada Materi Sistem Ekskresi untuk Meningkatkan Keterampilan Berpikir Kritis Siswa***

**ABSTRAK:** Keterampilan berpikir kritis siswa di sekolah masih kurang. Media pembelajaran yang masih berupa buku paket kurang efektif dan interaktif dalam proses pembelajaran. Penelitian ini bertujuan untuk menganalisis peningkatan keterampilan berpikir kritis siswa menggunakan e-handout berbasis 3D. Penelitian ini merupakan jenis penelitian true-eksperimen dengan desain penelitian pretest-posttest control group design. Populasi dalam penelitian ini adalah seluruh kelas XI MIPA di SMAN A Ciwaringin berjumlah 128 siswa dan sampel yang digunakan adalah kelas XI MIPA 1 dan XI MIPA 2. Terdapat peningkatan keterampilan berpikir kritis siswa yang signifikan antara kelas eksperimen dengan rata-rata nilai N-gain kelas eksperimen 0,60 tergolong kedalam kriteria sedang sedangkan nilai N-gain kelas kontrol 0,28 tergolong kedalam kategori rendah.

### INTRODUCTION

Students must meet various competencies in current school-based learning (Küsel et al., 2020);(Immonen et al., 2019). Students must have 21st-century skills, one of the competencies (Novitasari et

al., 2022). There are six 21st-century skills that students must have, which are then known as 6C: character, citizenship, critical thinking, creativity, collaboration, and communication (Fadhilawati et al., 2023).

Students must have critical thinking skills in the 21st century (Mudaningrat et al.,

2022). Critical thinking is a deep action or mode of thinking in which people completely study facts and seek the truth of information gained (Puspita et al., 2019). Critical thinking is done through questioning, analyzing, interpreting, evaluating, and judging information obtained from reading, listening, speaking, or writing (Sari et al., 2021). Haka et al. (2021) state that students must have deep and high cognitive thinking skills to comprehend the learning process. This critical thinking skill is essential for students to have since it can assist them in making decisions (Baguma et al., 2019).

The current state of critical thinking skills of high school students in various Indonesian schools is poor. According to Susilawati et al., (2020), 64% of students have low critical thinking skills, and two of the eight indicators in the study are in the medium category, while six are in the low category. Students, teachers, and other variables that assist the learning process can all contribute to poor critical thinking skills. This statement is reinforced by Akhmad (2019), who discovered challenges in grasping the subject, particularly critical thinking in 21st-century learning, as seen by the average student score, which remains below the criteria of minimum mastery (75).

The low-category critical thinking skills are partly caused by memorization methods in the learning process instead of understanding the concept of the material. Therefore, students find it difficult to connect concepts and problems the teacher presents in the learning process (Nur et al., 2020). Saputri et al. (2019) supported this finding. They found that students' critical thinking skills remained low in one of Surakarta's high schools. It can be seen through the symptoms of issues that predominate in the outcomes of observations made during the biology learning process in the classroom. (1) students are less thorough in analyzing a problem; (2) difficulty working on high-level problems (C4-C6); (3) some students are passive when doing group assignments; (4) many of them find it challenging to connect

concepts and problems; and (5) some students have difficulty expressing their opinions during discussions (Arafa et al., 2021).

Teaching materials are an introduction to information or knowledge offered by teachers to students during the teaching and learning process (Syara et al., 2020). Teachers, as the subject of information transfer, are sometimes ambiguous in conveying material to students because the object of the material is not directly in front of the student's eyes. Hence, interactive teaching materials are required. Teachers frequently employ printed package books, worksheets, modules, or internet sources as teaching resources (Pratama et al., 2020).

Technological advancements allow humans to get information more quickly and give rise to interactive teaching materials that can assist students in better understanding the subject offered by the teacher (Agustiawan & Nurcahyo, 2022). Not many learning media commonly found in schools are internet-based, interactive, or follow technological developments. A 3D-based e-handout is an electronic handout that can be downloaded via a website, where this e-handout can display interactive videos, photos, or links that are supposed to boost student knowledge and critical thinking skills (Handayani et al., 2020).

The human excretory system is one of the chapters in Biology that students can only learn by reading or imagining, so interactive or 3D-based teaching resources are required to ensure that the principles taught by the teacher are transferred to students. The 3D-based e-handout is one of the interactive teaching materials that is expected to be able to convey the concept of the excretory system to students well because it allows students to access videos, images, or links to support their understanding of the abstract concept of the excretory system (Erolin, 2019);(Koong et al., 2022).

Based on initial observations by conducting interviews with biology teachers of the eleventh-grade students at the

specified research location, it was decided that students' critical thinking skills remained in the poor category. Furthermore, 3D-based e-handouts have never been used in learning activities.

The e-handout utilized in class is a 3D flipbook, which makes the e-handout display appear realistic. Students can access videos relevant to concepts related to what the teacher delivers in class and links connecting to the 3D object display to promote student learning (Furukawa & Eyberg, 2019). Dharmono et al. (2020) found that handouts can boost critical thinking skills by an average of 91.8%.

Based on this context, this research aims to examine students' critical thinking skills development using 3D-based e-handouts in the eleventh grade at SMAN 1 Ciwaringin.

## METHOD

This study's population consisted of 128 eleventh-grade mathematics and science major students at SMA Negeri 1 Ciwaringin. This study employed a quantitative true-experimental technique with a pretest-posttest control group design. The research sample was divided into XI MIPA 1 as the experimental group and XI MIPA 2 as the control group. The experimental group received a 3D-based e-handout in this study, whereas the control group received an e-handout.

This study collected quantitative data through tests and qualitative data through student response questionnaires. According to Ennis, the instrument test consisted of 40 reasoned multiple-choice items based on indicators of critical thinking skills. The student response questionnaire contained responses from students who used the 3D-based e-handout. Students' pretest and posttest scores served as the quantitative data. The N-Gain value determined from the pretest and posttest scores was used to measure the significance of 3D-based e-handouts to improve students' critical thinking skills. The N-Gain value is used for

normality, homogeneity, and independent sample t-test.

## RESULTS AND DISCUSSION

The average pretest and posttest scores of the experimental and control classes differ significantly, with the experimental class having a higher average score than the control class. Table 1 displays the N-Gain values achieved by the experimental and control classes.

**Table 1.** N-Gain Values of the Experimental and Control Classes

Kelas	N-gain	Criteria
Experimental Class	0,60	Moderate
Control Class	0,28	Low

According to Table 1, the experimental class N-gain value of 0.60 is moderate, whereas the control class N-gain value of 0.28 is classified as low. There is an improvement in the experimental class that is greater than the control class identified based on the average value of pretests and posttests in the experimental and control classes. The experimental class has a higher N-gain value because using 3D-based e-handouts during the learning process makes it easier for students to absorb the material delivered. Wulandari & Djukri (2022) believe that the presence of media can aid student learning. Furthermore, the significance of the independent sample t-test was 0.000. This demonstrates that  $H_0$  is rejected, whereas  $H_a$  is accepted. Based on this data, there is a substantial difference in increasing critical thinking skills between students who use 3D-based e-handouts on excretory system information and students who do not use 3D-based e-handouts. According to Wuryanti & Kartowagiran (2016), there is a distinction between classes that use media and those that do not.

There are significant variations in pretest and posttest scores between the experimental and control groups. The experimental class pretest score was lower than the control class because the class conditions were not calm and conscientious when working on questions, causing

students to have difficulty concentrating, resulting in many questions being answered incorrectly (Khairunisa, 2021); (Damayanti et al., 2018). Concentration is essential for developing critical thinking skills. This finding is consistent with research conducted by Winata (2021), who found that concentration can help students better master the material while increasing enthusiasm and motivation to be more active during the learning and teaching process. If someone has difficulty concentrating, the teaching and learning process is not optimal.

After using e-handouts in learning activities, the experimental class's posttest results improved. This is because e-handouts give a more immersive learning experience by displaying 3D objects rather than just photos. This 3D object display helps students understand the content more clearly and concretely. According to Haka & Suhanda (2018), students' increasingly visible learning experiences ensure their thinking skills.

Furthermore, using 3D-based e-handouts with a flipbook display after learning can increase competencies since they are simple to understand and engage. This finding is consistent with Wahyu et al. (2023) that using template design and feature settings, such as background colors and illustrations, control buttons, navigation bars, and book pages for displaying flipbooks makes them more interactive and attracts students' attention, resulting in more effective learning. Aprilia (2021) also believes that the appearance of media with a visually appealing design will encourage children to learn properly. The availability of appealing media will make it easier for students to understand the material, develop skills, conclude, and present, all of which are indicators of critical thinking (Khosiah et al., 2022).

On the experimental class posttest score, the indicator of interacting with others obtains the greatest value due to the clear nature of the 3D-based e-handout, which makes it easier for students to find solutions

during discussions or as a learning resource in grasping the material delivered by the teacher. The ease with which students may obtain answers helps them learn concepts more quickly, and the process of discussion and presentation in class becomes more lively, increasing the average value of indicators of interacting with people above other indicators (Muliana, 2021). Simamora (2020) shows that using interactive multimedia allows certain students to learn the topic quickly and share advice or experiences with other students. Kartika et al. (2019) claim that if people are having trouble using multimedia, they can seek other groups for help to introduce interaction to learning using interactive multimedia.

One of the media and interactive learning elements is a 3D-based e-handout. Interactive learning resources make it easier for students to understand concepts taught in class by professors. This finding is consistent with previous research by Suganti & Fizah (2023) on the effects of interactive learning media on critical thinking skills, namely that the experimental class's critical thinking skills are greater with an average value of 76.75 and the control class's critical thinking skills are 70.5, with the highest increase in the indicator focusing on statements of 74.58%.

Handouts are learning summaries that teachers deliver to students during the classroom learning process. Electronic handouts, sometimes called e-handouts, are online learning resources students can access via web pages. This study used 3D-based e-handouts, with e-handouts forming 3D flipbooks. There are 3D objects of excretory system organs that may be accessible over the web in the 3D-based e-handout, as well as films of material on the development process of excretory substances. The control class's e-handout only contains learning materials given via links. The 3D item displayed on the e-handout gives students a more realistic view of the excretory system organs than 2D

photos. This statement is consistent with the findings of Fajrin et al. (2023), who discovered that learning resources can be created from items used at the teacher's discretion to make the teaching process unconstrained. To make learning more meaningful, it must include learning resources that can influence students' better thinking based on their developmental stages, such as 3-dimensional (3D) learning media (Saputri et al., 2019).

According to the findings, 3D-based e-handouts can boost students' critical thinking skills far more than simply using e-handouts. Using 3D-based e-handouts provides students with a more authentic and dynamic learning experience, making the learning process more fun and easier to understand the learning concepts received in class.

## CONCLUSIONS AND SUGGESTIONS

Based on the findings, it is possible to conclude that there is a significant difference in improving students' critical thinking skills between the experimental class, which uses 3D-based e-handout, and the control class, which only uses e-handout on excretory system material, as evidenced by the N-gain values of the two classes. The average N-gain value of the experimental class is bigger than the average N-gain value, with the experimental class's N-gain value of 0.60 categorized as medium and the control class's N-gain value of 0.28 classified as low.

Based on the findings of this study, it is suggested that teachers use 3D-based e-handouts during the classroom learning process because they can improve students' critical thinking skills and are more effective and efficient in delivering material because they are concise and interactive, making the learning process more enjoyable. Second, 3D-based e-handouts can be applied to other materials, particularly organ system materials, requiring organ systems to be more realistic than 2D representations.

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