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Utilization of Augmented Reality, Google Search, and ChatGPT on Students' Concept Mastery in Excretory System Material

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Abstract: The Industrial Revolution 4.0 and Society 5.0 are being widely implemented in various countries. Combining these two things is expected to create an inclusive society where everyone can enjoy the benefits of technological developments. To keep up with developments in the world of education and increase the appeal and effectiveness of learning, Augmented Reality (AR) technology needs to be utilized. Likewise, Google Search technology can facilitate the collection of information. The existence of Artificial Intelligence, such as ChatGPT, is no less useful as a complement to the learning process that can expand and facilitate literature searches. This study compares the increase in concept mastery using AR with Google Search and AR with ChatGPT. The focus of this study is not on the comparison of AR use because AR is combined with the use of Google Search or ChatGPT. The research method uses quantitative research with a quasi-experimental design. The research instrument used was a multiple-choice test to measure students' concept mastery of the human excretory system material. The study results showed an increase in concept mastery in each group. However, there was no significant difference between the two groups.

Keywords: Augmented reality; ChatGPT; Concept mastery; Google search

Introduction

According to Harun (2021), the Industrial Revolution 4.0 is widely implemented in various countries. The technologies used include applying the latest Internet of Things (IoT) technology, artificial intelligence (AI), big data, robotics, and blockchain in the industrial and manufacturing sectors. The main focus of the Industrial Revolution 4.0 is the industrial process, namely increasing efficiency, productivity, and automation.

On the other hand, Society 5.0 is no less important to implement. Society 5.0 focuses on the use of technology that is not only used in industrial needs but also in people's lives. This is expected to create an inclusive society where everyone can enjoy the benefits of technological developments. To realize the goals of Society 5.0, advanced technology in the field of education needs to be integrated to serve human needs along with the development of the times.

One of the technologies that can be used as a learning medium is Augmented Reality. Augmented Reality positively influences various fields, such as business, entertainment, manufacturing, robotics, military, health, education, and many more (Aditama et al., 2019; Prananta et al., 2024). Augmented Reality can be beneficial in teaching and learning activities. However, it should be emphasized that the role of an educator cannot be replaced. Augmented Reality maximizes the learning process which is expected to impact learning outcomes (Amsyar et al., 2023; Widiasih et al., 2023).

Augmented Reality technology uses electronic devices to connect virtual objects and information with real-world objects (Bujak et al., 2013; Wong et al., 2014). Due to its ability to provide on-demand multimedia

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content and interactions that are not available in real-world settings, Augmented Reality has been used to support learning in a variety of subjects such as biology, physics, mathematics, and medical education (Akçayır et al., 2016; C. Chen et al., 2020; Ferrer-Torregrosa et al., 2015; Kamphuis et al., 2014; Lin et al., 2015).

A recent review of the use of Augmented Reality in education concluded that the most positive impacts of Augmented Reality were academic success and learning motivation (Altinpulluk, 2019; Amirahma et al., 2024; Hidayat et al., 2024; Naf'atuzzahrah et al., 2024; Tanjung et al., 2024). Other researchers argue that the digital augmentation provided by Augmented Reality serves as a form of scaffolding for learning and found significant information that Augmented Reality greatly assists conceptual understanding in science (Parani et al., 2023; Rosyid et al., 2024; Yoon et al., 2013). Augmented Reality has been used to support science inquiry learning. For example, Chiang et al. (2014) found that Augmented Reality improved student achievement in science inquiry activities. Ibili (2019), Liu et al. (2020), Thees et al. (2020), Buchner et al. (2021), Chen et al. (2023), Baidoo-Anu et al. (2023) stated that with the help of Augmented Reality, it can alleviate some cognitive demands because the capabilities of Augmented Reality on mobile devices can divide and increase students' attention which can lead to high levels of learning.

In realizing the goals of Society 5.0, one of them is using the emergence of Artificial Intelligence, one example of which is ChatGPT. Advances in artificial intelligence have led to the development of large language models, such as ChatGPT, which can provide more precise and contextually relevant answers to user questions and offer convergent information widely sought by users (Wu et al., 2024). The results were found in studies on the use of ChatGPT in several fields, such as those conducted by Hopkins et al. (2023), Johnson et al. (2023), and Kleesiek et al. (2023). They found that ChatGPT has been tested for its effectiveness in improving health, communication, and education services.

Kasneci et al. (2023) stated that using ChatGPT in education is a potential thing because of the various capabilities offered by this Artificial Intelligence. Using ChatGPT, opportunities to improve the learning and teaching experience can be obtained for individuals at all levels of education, including elementary, secondary, higher, and professional development. In addition, because each individual has unique preferences, abilities, and learning needs, ChatGPT offers a unique opportunity to provide a personalized and practical learning experience.

Al-Maroof et al. (2024) provide information on their research findings comparing the use of Google Search and ChatGPT. The results show that ChatGPT can substantially influence the reception of information to users; this can bridge the realm of information obtained, the perceived learning value, and the satisfaction felt by students compared to using Google Search. Other research results found by He et al. (2024) show that ChatGPT allows users to ask more diverse questions quickly but can produce wrong answers, while Google Search makes answers more reliable, but users can fail to find the answer.

To keep up with developments in education and increase the appeal and effectiveness of learning, Augmented Reality technology can be utilized in the learning process, both in and outside of school. Likewise, using Artificial Intelligence to complement the learning process can expand and facilitate literature searches.

So many biology subjects need to be studied by students from elementary to high school. One of these biology subjects is the subject of the human excretory system. The excretory system is one of the critical systems in the body, and students need to understand this system because by understanding the excretory system, students can understand how their bodies function, especially in terms of removing metabolic waste substances that are toxic to the body if not excreted. Students are also aware of the importance of maintaining the health of the excretory organs, which impacts a healthy lifestyle (Oktavianda et al., 2024; Putri et al., 2023).

Based on the description of the problems obtained in the field and the results of previous studies, the purpose of this study was to integrate three modern educational technologies. This combination of learning has not been widely studied in the context of mastering the concepts of biological material, especially the excretory system because the excretory system material is often considered abstract by students. After all, it involves many concepts that are not easily observed directly. This study offers an approach to help students visualize and understand the concept better. This study explores the potential of AI in supporting the learning of complex material. This study also offers a comparative approach to assess how this combination of technologies affects student learning outcomes.

This makes researchers interested in trying to find and analyze whether there is an increase in concept mastery and learning motivation and whether there is a reduction in students' cognitive load by using learning multimedia, namely Augmented Reality with the help of Assemblr Edu, Google Search engine and ChatGPT 3.5 in a series of learning. It should be emphasized that this study's focus is not on comparing the use of Augmented Reality because Augmented Reality will be combined with the use of Google Search or ChatGPT. In this study, Augmented Reality is not separately seen in its influence on student learning outcomes. Researchers investigated the results of using multimedia on students' concept mastery in Biology learning on the Human Excretory System material.

Method

The research method used in this study is quantitative research, categorized as experimental. The type of experimental research is used to test a treatment, in this case, the use of Augmented Reality + Google Search multimedia and the use of Augmented Reality + ChatGPT multimedia on students' mastery of concepts. The research design used in this study is quasi-experimental, especially the pretest-posttest control and experimental group design (Fraenkel et al., 2012).

Two groups were given a pre-test (O_1) to identify students' initial abilities and learning motivation. The next step was providing treatment (X) by learning multimedia on the material of the human excretory system. The last step was to provide a post-test (O_2) to measure changes in the dependent variable before and after the treatment was given. The research design can be seen in Table 1.

Table 1. Pretest-Posttest Control & Experimental Group Research Design

Group	Pre-test	Treatment	Post-test
Augemented Reality + Google Search	O_1	X_1	O_2
Augemented Reality + ChatGPT	O_1	X_2	O_2

Note:

O_1	:	Pre-test
O_2	:	Post-test
X_1	:	Treatment in the form of using Augmented Reality + Google Search
X_2	:	Treatment in the form of using Augmented Reality + ChatGPT

This research was conducted in one of the junior high schools in the city of Bandung. The population of this study was the mastery of the concept of grade VIII students on the material of the human excretory system. The sample used in this study comprised students who completed and collected all the tasks given during the pretest, treatment, and posttest. The tasks given were in the form of multiple choice questions (given before and after treatment) and student worksheets given to students during the learning activities.

The purposive sampling technique was used to determine the sample used as the research subject. The purposive sampling technique is specifically for groups that support the research objectives (Cresswell, 2017). The supporting group in question is a class where all students have smartphones or smartphones and are skilled at operating the device to support QR Code scanning, accessing and using the web, and so on that support the research process. The sample consists of two classes divided into two sample groups: one class for the group using Augmented Reality + Google Search and one class for the group using Augmented Reality + ChatGPT.

Pretest on concept mastery was given to each group (Augmented Reality + Google Search group and Augmented Reality + ChatGPT group). Conducted at the first meeting before the learning activity was carried out.

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Learning uses a discovery approach, discovery learning model, and discussion method.

↓

Students learn in groups. The teacher guides group discussions according to the instructions on the student worksheet.

↓

During the learning process, students use Augmented Reality by scanning the barcode on the student worksheet. Students fill out the student worksheet with the help of teaching materials provided by the teacher and Google Search or ChatGPT (according to the research group).

↓

Augmented Reality + Google Search	***Augmented Reality + ChatGPT***
Students are only allowed to use Google Search.	Students are only allowed to use ***ChatGPT***.

Students need to combine the answers obtained from their group members' findings with discussion activities to get the answer that is considered most appropriate.

↓

The teacher guides and accompanies students in completing the student worksheet.

↓

Representatives from each group present the results of their work.

↓

The teacher provides reinforcement regarding student work.

↓

Posttest on concept mastery given to each group (Augmented Reality + Google Search group and Augmented Reality + ChatGPT group). Conducted at the last meeting after the learning activities are completed (fourth meeting).

Figure 1. Learning activity implementation stage

Mastery of human excretory system material using limited response assessment, especially multiple choice. The questions consist of 20 with a range of cognitive levels C1-C4 (concerning the revised Bloom's Taxonomy). Researchers developed this instrument by adjusting the indicators in the human excretory system material. The instrument is adjusted to the learning outcomes to be achieved by students. The curriculum used is the Merdeka Curriculum.

Each instrument in this study was tested and analyzed to determine the validity and reliability of whether the instrument needs to be repaired, replaced, or can be used directly. This analysis aims to identify whether there are deficiencies in an instrument item and whether there is a need for improvement in these deficiencies. Instrument analysis uses the help of Anates 4.0.2 software and IBM SPSS Statistics 26.

The test instrument data was given at the beginning and end of the entire study (pretest and posttest). The data obtained were processed into average values, N-gain score calculations, and learning completion categorization. The learning completion category is guided by Arikunto's (2019) cognitive aspect of learning completion. The range of values and categories can be seen in Table 2.

Table 2. Learning Completion Category (Cognitive)

Value Range	Category
81 - 100	Very good
61 - 80	Good
41 - 60	Pretty good
21 - 40	Not good
0 - 20	Very less

The concept mastery instrument data were tested for normality and homogeneity as prerequisites for advanced statistical tests. The advanced statistical test used was the mean difference test. After this, data was tested for N-Gain to measure the increase or improvement in learning outcomes after intervention or treatment. The results of the N-gain achievement calculation were interpreted and grouped based on the N-gain score division criteria or the N-gain effectiveness interpretation category referring to Hake (1999). The N-gain score division criteria or the N-gain effectiveness interpretation category can be seen in Table 3.

Table 3. Gain Score Distribution or N-Gain Effectiveness Interpretation Categories

N-Gain Value Range	Category
(g) > 0.70	High
0.3 ≤ (g) ≤ 0.70	Medium
(g) < 0.30	Low

Result and Discussion

Concept mastery data in each class is compared using the average difference test. This test is intended to see the picture of the differences in each group's pretest and posttest data. Before the data is processed for the average difference test, the data needs to be known first whether the data is normally distributed and homogeneous. The data needs to be tested for its prerequisites. Table 4 is a recapitulation of statistical tests from the pretest data.

Table 4. Recapitulation of Statistical Test of Pretest Data on Concept Mastery in Both Classes

Data	Augmented Reality + Google Search (n=34)	Augmented Reality + ChatGPT (n=34)
Normality test (Shapiro-Wilk)	Sig. 0.13 (Normal)	Sig. 0.33 (Normal)
Homogeneity Test (Levene's Test)		Sig. 0.82 (Homogeneous)
Mean Difference Test (Independent t-test)		Sig. 0.13 (There is no significant difference)

It can be seen in Table 4 that the results of the normality test indicate that the pretest data in each class is normal because each value in both data is > 0.05. Likewise, in the homogeneity test. The p value> α (0.82> 0.05) means that this data is homogeneous. Both prerequisite tests have been met; the data is normal and homogeneous. Therefore, the type of average difference test chosen is a parametric test, namely the Independent t-test. The Independent t-test was chosen, and the researcher compared the average between two independent groups: the pretest data in the Augmented Reality + Google Search group and the Augmented Reality + ChatGPT group.

Decision making on the Independent t-test is if p < α (0.05), then the data interpretation is that there is a significant difference in both data. And vice versa. The result of the Independent t-test obtained was 0.137. This indicates no significant difference between the pretest data in the Augmented Reality + Google Search group and the Augmented Reality + ChatGPT group. Furthermore, the posttest data table from each group is presented in Table 5.

It can be seen in Table 5 that the results of the normality test indicate that the posttest data in each class is normal. Likewise, the homogeneity test obtained that the data is homogeneous. Both prerequisite tests have been met; the data is normally distributed and homogeneous. Therefore, the type of average difference test chosen is a parametric test, namely the Independent t-test. The results of the Independent t-test obtained were 0.09. This states that there is no significant difference between the posttest data in the Augmented

Reality + Google Search group and the Augmented Reality + ChatGPT group.

Table 5. Recapitulation of Statistical Test of Posttest Data on Concept Mastery in Both Classes

Data	Augmented Reality + Google Search (n=34)	Augmented Reality + ChatGPT (n=34)
Normality test (Shapiro-Wilk)	Sig. 0.12 (Normal)	Sig. 0.27 (Normal)
Homogeneity Test (Levene's Test)		Sig. 0.92 (Homogeneous)
Mean Difference Test (Independent t-test)		Sig. 0.09 (There is no significant difference)

The data listed in Table 6 and Table 7 show that the pretest and posttest results in both classes are not much different. This is supported by the results of the average difference test, namely the Independent t-test. The results showed no significant difference between the pretest and posttest data in the Augmented Reality + Google Search group and the pretest data in the Augmented Reality + ChatGPT group. In other words, it can be said that the student's abilities before and after learning in these two classes are not much different or equivalent.

Table 6. Concept Mastery Results in Each Class

Aspect	Class	Lowest Score	Highest Score	Average
Prettest	Augmented Reality + Google Search	10.00	45.00	25.40
	Augmented Reality + ChatGPT	10.00	45.00	28.90
Posttest	Augmented Reality + Google Search	50.00	90.00	71.20
	Augmented Reality + ChatGPT	55.00	95.00	76.20
N-Gain	Augmented Reality + Google Search	0.29	0.88	0.61
	Augmented Reality + ChatGPT	0.31	0.94	0.66

Table 7. Statistical Test of the Difference in Average Data of Pretest and Posttest Concept Mastery in Both Classes

Data	Pretest	Posttest
Mean Difference Test (*Independent t-test*)	0.13 (There is no significant difference)	0.09 (There is no significant difference)

Reisberg (2019) stated that concept mastery is part of cognitive ability. Concept mastery is the basis of learning because students can explain and re-express what has been communicated to students (Pamungkas et al., 2023; Unaenah et al., 2019). Unaenah et al. (2019) explained that low conceptual understanding can result in limited use of students' ideas, skills, and knowledge.

Likewise, Cao et al. (2024) stated that conceptual mastery is essential to the teaching and learning process. Students with good conceptual mastery will find it easier to understand new information, apply their knowledge in various contexts, and solve problems effectively.

Overall, the results increased before and after learning in the Augmented Reality + Google Search and the Augmented Reality + ChatGPT classes. However, the average N-gain value was still in the moderate category. This increase can be developed and improved further by discussing concept mastery questions that have previously been tested on students. By re-discussing questions that have been tested previously, it can prevent students from continuing to choose the wrong answer. Students will know why the answer options they choose are wrong, while students who have chosen the correct answer can be more confident in their answers (A. D. Putri, 2022). Another alternative is a learning evaluation carried out with students. This activity aims to obtain information about the success of learning so that teachers can ask for input from students regarding the flow of the learning process that has been implemented (Magdalena et al., 2023).

The content of Augmented Reality used by students in the learning process of the human excretory system is the structure of organs in the human excretory system (skin, lungs, liver, and kidneys). Students are asked to determine, describe, and find the function of each label the researcher has previously labeled empty (such as label a, label b, and so on) in the structure section that supports the learning process. From the many organ structures that have been labeled, students need to determine which organ structure is an essential point in the excretion process. Students explain their reasons and then strengthen them by explaining how each organ and the organ structure they choose work in excreting the body's metabolic waste. Students are also free to collect information about disorders or abnormalities of the excretory system they most want to know. In finding these disorders or abnormalities, students must determine which part of the organ structure is problematic. If the organ structure section is found in the organ presented by Augmented Reality, students must write down the problematic organ structure with the label in Augmented Reality. The use of Augmented Reality in learning in both classes has the same use. Researchers do not provide any differences in the provision of Augmented Reality.

In the learning process using Augmented Reality, students use their smartphones enthusiastically. One of the characteristics is that they do not just swipe or simply enlarge or reduce the screen of their cell phones to see the organs displayed in Augmented Reality. However, they ask many questions about the color, shape, size, and location of the organ structure labeled by researchers. They ask more questions to their group members than to the teacher directly. Their group members are also unable to answer their friends' questions. Then, they look for answers to their questions together and share answers.

Hurst (2020) stated that learning media using Augmented Reality can improve students' understanding through 3D object visualization in science learning, and the results obtained in this study are also in line with the question that the use of Augmented Reality can improve students' mastery of concepts (in both classes). The content of Augmented Reality in the study presents the organ structure of the excretory system organs. Several other research results that use Augmented Reality by presenting a human body organ that discusses the variable of concept mastery are studies by Wulandari et al. (2020), Fajriani et al. (2021), Rohmah et al. (2021), Annisa et al. (2023), Pamungkas et al. (2023), and Widiasih et al. (2023). The findings of these researchers are the same as the research results obtained in this study.

In completing the student worksheet and using Augmented Reality, students are also asked to search for sources of information with the help of Google Search and ChatGPT. As the results obtained and previously reported, there is no significant difference in the posttest data on students' mastery of concepts in classes using Augmented Reality + Google Search and classes using Augmented Reality + ChatGPT. This is because the use of Google Search and ChatGPT has the same purpose: to help students find as much information as they need. However, the difference in ease of obtaining information is of great concern in these two media.

To search for information using Google Search, students need to type a question or statement regarding the information they want to get. Afterward, they will be presented with various information content offered by Google Search results, be it information from Blogspot, scientific articles, YouTube, etc. They need to search again for the content they need the most to answer the questions they consider most correct to answer the questions they are looking for answers to. In the learning process, students in groups need to find as many answers as possible (according to their needs) that they get from Google Search. Then, they need to have a discussion to combine or choose the answers that are considered most appropriate to answer the question guide available in the student worksheet.

On the other hand, classes that use ChatGPT in searching for learning information are more practical in getting answers. At the beginning of the search for information, students in the ChatGPT class and students in the Google Search class must type questions or statements about the information they want. However, when using ChatGPT, specific questions are also required to get particular answers. If the questions given are still very general, then the answers displayed by ChatGPT will be general and broad (Hassani et al., 2023). Therefore, the ability to summarize and state questions is explicitly needed.

At the first meeting, the researcher found that students were not used to using ChatGPT. After asking one question, they were satisfied with the answer they got. The answer to one question does not necessarily represent the answer to the question in the student worksheet. The difference in the average score of the student worksheet for the first meeting of the ChatGPT class was ten points lower than the average score of the student worksheet for the first meeting of the Google Search class. The ChatGPT class got an average of 68.00, while the Google Search class got an average of 78.00. ChatGPT allows users to ask more diverse questions but can produce wrong answers. On the other hand, Google Search provides many sources of information, making answers more reliable, but users may fail to find the answer (He et al., 2024). This changed as the class meetings progressed.

At the last meeting, which was the fourth meeting, the ChatGPT class got an average score of 93.00, while Google Search got a score of 89.00. The more often students use ChatGPT, the more they understand how to use it well. The researcher found that when answering a question at the fourth meeting, they asked again about things they did not know in the answer given by ChatGPT using the "reply" feature. This feature makes it easier for users to focus questions on several answers to words or sentences that ChatGPT displays that the user wants to ask again. The researcher found that many students asked for much more complex things than those requested by the student worksheet.

The answers to the student worksheet written by the class using Google Search also improved day by day. However, the researchers found that only about three-quarters of the students in each group discussed which answers they thought were the most correct to write on the student worksheet. This differed from the ChatGPT class, where they were more interested in providing as many answers as possible.

In this study, the use of Augmented Reality + Google Search and Augmented Reality + ChatGPT in learning did not significantly differ, especially in the concept mastery variable. This can occur due to several factors. For example, there are external factors, namely the situation of students when filling out the posttest, the duration required when filling out the posttest, the length of questions or answers, students' lack of attention in reading questions and reading answer choices, students' lack of readiness in learning, to other environmental factors (Inayah, 2024).

Conclusion

Students' concept mastery in the Augmented Reality + Google Search class showed a moderate increase with an N-gain of 0.61. Students' concept mastery in the Augmented Reality + ChatGPT class showed a moderate increase with an N-gain of 0.66. There was an increase in concept mastery in each group. However, overall there was no significant difference between the group using AR with Google Search and the AR group with ChatGPT obtained from the results of the average difference test on the pretest or posttest of student concept mastery.

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Author Contributions
Yenni Verawati, wrote the introduction, methods, results, discussion and conclusions. Adi Rahmat and Yayan Sanjaya supervised and edited.

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Conflicts of Interest
All groups in this study used Augmented Reality. The researcher could not definitively determine whether Augmented Reality affected each variable in this study, namely the concept mastery variable. Nevertheless, these findings provide valuable insights into how different information retrieval methods can interact with Augmented Reality technology to influence students' learning experiences.

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