

## Using hologram-based modules to address learning loss in elementary students

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### ABSTRACT

Learning loss can be characterized by several things such as a lack of student interest in learning where students are not focused and easily lazy in learning. This learning loss will get worse if the material presented in the lesson is abstract in nature and cannot be seen in real terms by students. With the use of a hologram projector, this study intends to evaluate the efficacy of interactive learning media in the form of hologram-based learning modules. In this case, quasi-experimental research methodology through nonequivalent control group design was employed in this study. The sampling technique is purposive sampling. The two sample classes used are class VI A (control) VI B (experimental). The results of the independent t-test on sig. (2-tailed) of  $0.001 < 0.05$  indicate a significant difference between the results of the control class and the experimental class. The effectiveness of the N-Gain pretest and posttest of student learning outcomes in the control class were 0.25 in the low category and 0.57 in the experimental class in the medium category. Therefore, the study findings indicate that hologram-based module, aided by a holographic projector, was deemed to be useful for use in the learning process. The conclusion of this study is that it is expected that teachers and educators will be able to employ engaging and tangible learning materials and be supported by technology, with the usage of holograms being one of the choices.

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## 1. INTRODUCTION

During the Covid pandemic, remote teaching and learning activities are the best substitute to be implemented in order that teaching and learning activities can be carried out continuously despite students being at home. The global spread of the Corona virus (COVID-19) pandemic is having an impact on a wide range of human endeavors, from the reduction in industrial production to the revision of the academic calendars at all international educational institutions [1]. Online learning activities are activities influenced by relatively inexpensive media equipment, higher internet speeds, and students' access to mobile devices [2]. Concerns regarding the effects on student learning have been expressed as a result of the suspension of face-to-face instruction in schools during the COVID-19 epidemic [3]. Such concerns regarding the COVID-19 pandemic's potential to have a detrimental influence on students' academic performance were expressed as it developed [4]. The COVID-19 epidemic has demonstrated that, although learning may occasionally happen without instruction, on a large scale, and particularly among the most disadvantaged and vulnerable children, learning does not usually happen when children are denied access to instructors and

instruction [5]. Online learning has faced several criticisms concerning its quality compared to traditional face-to-face. Nevertheless, it tends to provide opportunities for student-centered learning, as the flexible scheduling enables students to access a broader range of learning materials and learn at their own pace independently [6]. About 90% of students worldwide were affected by the COVID-19 epidemic, which forced whole educational systems to switch to remote and online instruction [7]. All schools in Indonesia are encouraged to implement distance learning by utilizing information technology. There have been many public responses regarding this policy, and in general, all parties agree. Face-to-face learning activities were replaced with distance learning, meaning that classes were conducted through virtual online meetings and teachers assigned students to work independently using their textbooks [8]. This is reinforced by the observations that schools have not been able to maximize the teacher's role in producing appropriate learning media during the pandemic and after the pandemic so that the learning process is still teacher-centered and uses makeshift media. To overcome this problem, researchers develop learning media that can be implemented based on hologram technology and also consider pedagogic and themes that will make students active and can increase effective and meaningful learning.

The online learning environment has its pros and cons for student learning. On the one hand, Terras and Ramsay [9] shows that in order to improve learning chances, kids can regularly view educational films online. On the other hand, Lodge and Harrison [10] found that the use of technology in the learn process has a negative impact on the brain. They should also create a learning environment for prospective teachers to carry out their preparation keeping in mind the requirements of teacher education programs and the conditions under which universities and schools must operate [11]. Videos appear to have a good impact on students' academic performance and attitudes toward instruction and learning [12].

Almost every region in Indonesia has adopted the distance learning method. In response to the pandemic, online learning has been implemented at all levels, from primary to higher education. Online learning cannot be separated from its advantages and disadvantages [13]. The advantages of online teaching and learning activities include: i) educational institutions can properly track technological advances, pay close attention to the need for training facilities that are suitable for online teaching and learning activities, can manage their own data management system and invite teachers to be able to update in carrying out teaching and learning activities; ii) students better understand technology, practice independence and responsibility, save time spent and are able to use gadgets well; iii) parents can monitor how children's teaching and learning activities can be accompanied by accompanying children's practice activities; and iv) profitable for several industries that are very functional in supporting online teaching and learning activities such as internet service facilitators, electronics industries, and application creator industries [14].

Apart from having advantages, online learning also has weaknesses, namely we don't know whether this child really understands the material sent via WhatsApp Group or not. It means that the parents are the ones who go to school, not their children. Then the third, there are students who don't have cellphones and don't know the information about the assignments given.

Indonesia is currently free from the shackles of the COVID-19 pandemic and is entering a new normal era. Where schools can carry out face-to-face learning. However, as a result of this pandemic that has hit Indonesia for almost 2 years, side effects are still being felt, one of which is learning loss among students. Learning loss is a consequence of abrupt change; often, individuals who experience learning loss are those who are not receptive to it. Changing habits and preparation for online learning is not an easy thing for teachers and students, due to several factors where the online learning process is carried out by means of students studying from home without being directly accompanied by the teacher, so that students feel less interaction with the teacher, ineffective delivery of material and the learning process which is only done in a short time. Due of this, online learning is not as effective as it might be, and many students miss out on the chance to advance their knowledge and abilities.

Learning loss can manifest in several ways, such as a decline in students' interest in learning, lack of focus, and a tendency to become easily disengaged. This often occurs during online learning, where students may feel a lack of purpose and motivation. Inadequate access to proper learning facilities further exacerbates the issue, making it difficult for students to obtain necessary learning materials-whether due to limited internet data or poor connection quality. Additionally, the lack of preparedness among teachers and parents to effectively guide students through online learning contributes to the problem. This condition of learning loss may worsen further if the instructional content [15] is presented in learning is abstract in nature which cannot be seen in real or real terms by students. Students are more likely to understand and retain information when they are able to observe it firsthand [16]. As a result, the extent of learning loss during an extended school closure may exceed the number of instructional days missed [17].

Based on the results of the literature study, it shows that the learning material that really needs contextual learning is science, this is because the teacher is still unable to explain the material in a complex manner and students only see the solar system in a book that is not moving. Even though the use of

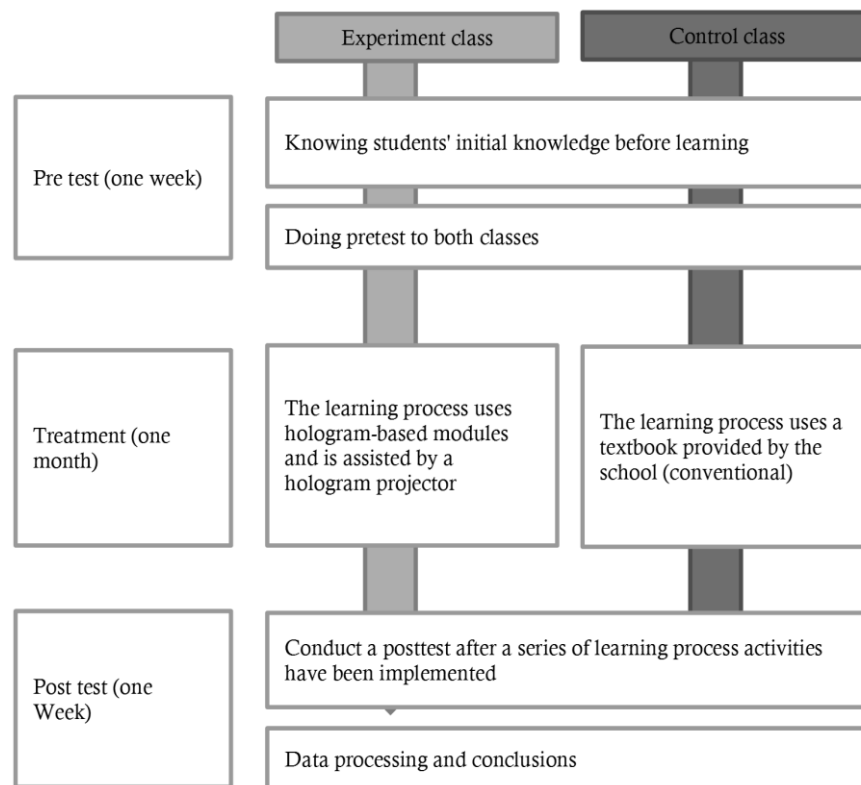
audio-visual media can be used like research conducted by [18] that with the help of audio-visual media it can convey difficult material more easily. Additionally, the cognitive processes and past knowledge of pupils might have an impact on their performance and attentiveness. Educators need to consider effective ways to utilize online platforms to enhance student learning beyond the classroom, especially in the post-pandemic period [19]. The problems described above are efforts that can be made by a teacher in order to reduce the impact of this learning loss by creating a learning device that can support students in independent learning and most importantly the device does not make students bored in learning independently. One of the learning devices in question is a module.

The goal of learning modules is to increase the usability, capability, and interest of the teaching participants so that they will practice what they have learned. In this case, learning modules are analytically developed by professionals in certain fields of study or the teaching profession [20]. A module can also be defined as instructional material structured in a logical, organized, effective, and goal-oriented way for students to study, and it includes a guide for teachers on how to use it [21]. Modules were created as independent learning resources for students. With the existence of modules, learning is no longer teacher-centered but student-centered [22]. The module will train students to be actively involved in the learning process so that students can learn directly from the experiences they encounter independently both inside and outside the classroom. The module's instructions and information presentation are clear and welcoming for the user, making it simple for them to reply and retrieve the information as needed [23]. Theories encompass ideas, guidelines, and suggestions for presenting information through text, speech, and visuals, selecting appropriate tasks, and enhancing student involvement while viewing educational videos [24]. In this case, holograms are an excellent teaching tool, at least when compared to textbooks, since better knowledge of the subject matter enables pupils to attain superior academic success [25].

The novelty of the modules combined with audio-visual media, one of which is holograms, will be able to make elementary school students more active in the learning process and the lessons will be enjoyable [26]. The hologram itself is a 3D visual medium that can help display images more clearly and realistically. Holography is a technique or method of image recording (optical) that is used to produce three-dimensional images based on interference events recorded on two-dimensional media, on this media it is called a hologram [27]. Holograms are a new technology that has the potential to be used in education [28]. Overall holograms encourage learning because they allow for the presentation of difficult concepts, offering detailed representations of objects, as opposed to two-dimensional representations such as pictures and photographs [29]. Hologram 3D technology can be applied as a learning medium for the introduction of the solar system so that users get information about the solar system in a better and more interesting way, namely by using technology [30]. In learning using 3D media can make abstract knowledge concrete and help students master science, technology, engineering, mathematics, and other knowledge [31].

Based on a previous study conducted by Ortega *et al.* [32] entitled "Application of the technical-pedagogical resource 3D holographic LED-fan display in the classroom", the results indicated that the use of the 3D holographic LED-fan display in the classroom should be encouraged as a techno-pedagogical resource. Student participation during the learning process significantly increases. In addition, its benefits and contributions to the teaching and learning process are highly valuable, as it introduces something new, engaging, and technological. Additionally, demonstrating is among the most efficient teaching strategies for grabbing students' interest and attention. Additionally, because it enables students to actively participate in the learning process, interactive learning is one of the most significant educational techniques. Holograms can be used to implement either or both [33]. The research researched by Wójcik [34] entitled "Holograms in libraries-the potential for education, promotion and services" found that hologram may be used for documentation, research, and displays, in addition to teaching, advertising, and services, so it offers a greater potential for usage in libraries than was initially anticipated. Although there are numerous advantages to using holograms, there are also certain concerns that need to be taken into account. In addition, research conducted by Mavrikios *et al.* [35] entitled "Using holograms for visualizing and interacting with educational content in a teaching factory". In this study, holograms are examined as a potential tool for bringing instructional material to the classroom. The holographic technology makes it possible to see intricate 3D models in real-size proportions, allowing many student teams to view the models at once. The use of warm colors, highlighting important keywords, and colored moving images provides better results as visualization tools in 3D holograms to capture children's attention in learning. Furthermore, research conducted by Loh and Shaharuddin [36] entitled "A proposed concept of learning-based 3D hologram to enhance attention among primary school learners" suggests that the use of warm colors, highlighting important keywords, and colored moving images yields better outcomes as visualization tools in 3D holograms for attracting children's attention in the learning process. Based on the problems described above, the researcher is interested in conducting research on the effectiveness of using hologram-based interactive modules to avoid learning loss among elementary students.

The research was conducted in November until december in 2023 at Sekolah Dasar Muhammadiyah (Muhammadiyah Elementary School) 002 Penyasawan. The research population is class VI students for the 2022/2023 academic year. The sampling technique is purposive sampling and random sampling. Justification used purposive sampling was carried out to select class levels that had material according to the hologram module, namely class VI. Then, from the class VI group, there were two classes, so they were chosen to determine which one was the control and which one was the experiment, which was carried out by selecting random sampling. The two sample classes used were class VI A (control) VI B (experimental) where each class had 30 students. The description of the procedure in this study is as shown in Figure 1.



The research method uses a quasi-experimental method in the form of a non-equivalent control group design shown in Table 1. Based on the research design in Table 1 with R1=experimental class; R2=control class; X=learning using hologram-based modules; O1=initial test; O2=final test [37]. The research category experimental class carries out teaching and learning activities using material based on a hologram platform and assisted by a hologram projector, whereas the control class category uses training materials provided by schools. Before carrying out research in the field, the researcher conducted a pilot project to ensure that the media and instruments were valid and reliable to use.

| Class (n) | Pretest | Treatment | Posttest |
|-----------|---------|-----------|----------|
| R1 (30)   | O1      | X         | O2       |
| R2 (30)   | O1      |           | O2       |

The result of the expert judgment is that there are improvements in several statement items that are not in accordance with the construct and then have been refined for both the media and the instrument. then, researchers conducted a trial on 60 elementary school students and found that the results of testing the

construct validity and reliability show that the validity of the evaluation instrument for the use of hologram-based learning media for students has met the valid criteria because the value of  $r\text{-count} > r\text{-table}$  ( $r\text{-count} > 0.254$ ); and the reliability of the evaluation instrument that has been compiled and developed in this study also meets the high category as indicated by the magnitude of the Cronbach Alpha reliability coefficient of 0.980. In implementation in this research Both sample classes were given a pretest. before starting the teaching and learning activities and the posttest at the end of the teaching and learning activities. The information obtained after carrying out the research is processed using the N-Gain test and hypotheses. The N-Gain calculation is obtained from the pre-test and post-test scores of each experimental class (a class that uses a hologram-based module) and a control class (a class that uses conventional learning. The g factor (N-Gain) formula according to Sancho *et al.* is [37].

$$g = \frac{\text{Posttest score} - \text{Pretest score}}{\text{Ideal score} - \text{Pretest score}}$$

In this study the criteria for evaluating the N-Gain score used can be seen in Table 2. After confirming the N-Gain, the researchers carried out the normality follow-up experiment after which the independent t-test. The normality test is a procedure used to determine if the distribution of data in a batch of data is elastic and whether or not it is fairly distributed. After the data is categorized as normal, then further testing is carried out, namely the independent test. This independent t-test is a different test of two unpaired samples. Unpaired samples are the same object but experience different treatment.

Table 2. Score category

| Limit                 | Category  |
|-----------------------|-----------|
| $g > 0.7$             | Tall      |
| $0.3 \leq g \leq 0.7$ | Currently |
| $g < 0.3$             | Low       |

In student-centered learning, or active learning, students usually determine the classroom dynamics as they work independently. They are only provided with brief information about the video, and the teacher delivers the learning objectives [38]. According to Moussiades *et al.* [39], pyramid holograms outperformed traditional movies in terms of information retention, according to a research that compared the two. In order to determine the general comparison of the post-test results of student learning outcomes between class A (the control class) and class B (the research class), the independent t-test was conducted in this study by equating in general the post-test results of student learning outcomes between the control and experimental classes. Therefore, the researcher makes the following research assumptions:

- Ho: there is no difference in the N-Gain results of student learning outcomes between class A (control class) and class B (experimental class).
- Ha: there are differences in the N-Gain results of student learning outcomes between class A (control class) and class B (experimental class).

In the hologram-based module research in overcoming learning loss among students, it can be seen from the learning outcomes obtained by students because the characteristics of children who experience learning loss are decreased learning outcomes [40]. To find out the t-count value and independent t-test using the SPSS version 26 application based on the significance value (sig.), namely: if sig.  $< 0.05$ , then Ho is rejected and if sig.  $> 0.05$ , then Ho is accepted.

### 3. RESULTS AND DISCUSSION

This study integrates hologram-based learning into modules and uses smartphones and hologram projectors as learning tools to overcome learning loss during teaching activities. In comparison to traditional instruction, the experimental findings demonstrate that the hologram-based module enhances students' academic achievement, critical thinking, and learning pleasure. The first step that researchers can take to test the effectiveness of this hologram-based learning module is to determine the value (N-Gain) by giving pretest and posttest question sheets to the control class and experimental class. Which at this stage to find out the initial abilities of class A (control class) and B (experimental class) are given pretest questions totaling 8 questions and after giving the pre test questions are ready, then the next step is carrying out the learning process for class A and B by give different treatment. Class A carries out the learning process using commonly used learning media such as theme books or textbooks, while class B uses hologram-based learning modules with the help of hologram projects. The following is an overview of the modules tested.

*The effectiveness of using interactive learning media in the form of hologram-based ... (Rian Vebrianto)*

After the learning process is complete, students then work on post-test questions in which the pre-test and post-test questions have been tested for validity in measuring student learning outcomes. And from here we get the value (N-Gain) which we can see in Table 3. Additionally, for further clarification, the data is visually represented in Figures 2 and 3.

Table 3. Pretest and posttest results from the control class and the experimental class

| Group                 | Mark    |          | N-Gain | Category  |
|-----------------------|---------|----------|--------|-----------|
|                       | Pretest | Posttest |        |           |
| Control class (30)    | 40      | 55       | 0.25   | Low       |
| Experiment class (30) | 30      | 70       | 0.57   | Currently |

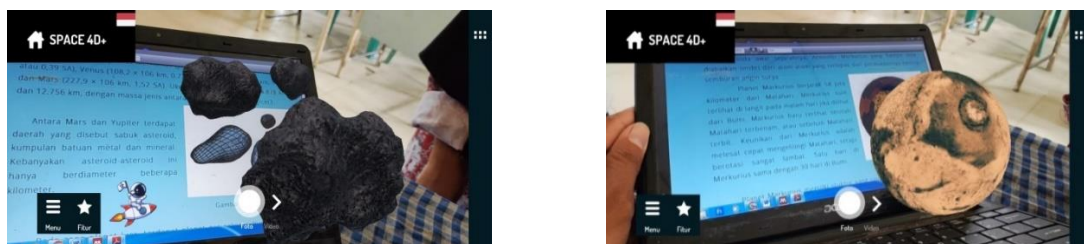


Figure 2. Hologram-based module

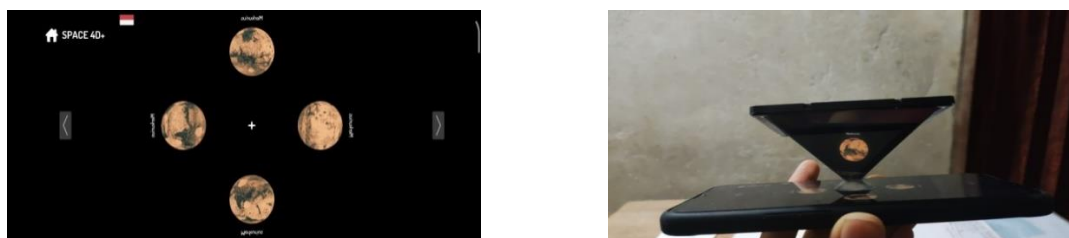


Figure 3. Hologram media and hologram projector tools

Based on Table 3, we can see that the results of the pretest and posttest for the control class were processed using the formula. Obtained N-Gain 0.25 with low category. For the experimental class, the pretest score obtained a value of 40 and for the posttest, a value of 70 was obtained. And after being processed using the formula, the N-Gain was obtained 0.57 in the medium category. It can be concluded that the hologram-based module that is applied to the experimental class is more effectively used. This is supported by research conducted by Dong *et al.* [41] which states that students can modify their learning speed in accordance with their own capacities when utilizing modules to study. Additionally, by using the module, students may gauge how well they understand the supplied information. And also supported by Panigrahy *et al.* [42] research conducted by meta-analysis methods and focus group discussions are used during the interpretation phase to assess factors that may influence children's attention, as well as how to create appropriate hologram 3D content in technical form learning support number. The hologram 3D-based virtual classroom framework model is developed in the concept phase as a result of the interpretation phase. During the experimental and evolutionary stages, it was found that identified key traits could increase student motivation to learn. Furthermore, research by Nurulita and Setiawan [43] found that the average cognitive learning outcomes of students who were given inquiry based learning (IBL) modules were better than students who were given learning using conventional models. In addition, research conducted by Sertalp [44] also found that 43 of the 48 research participants received scores above the minimum mastery criteria (>75), while only 3 received scores below the minimum completeness criteria (75), which means the level of student completeness of 89.5% which can be concluded that the modules developed are effectively used to improve student learning outcomes.

After obtaining the N-Gain results, a follow-up normality test is then carried out by the researcher to make sure that the combined data is normally distributed or drawn from a normal population. The same thing was carried out by research conducted by Zhang *et al.* [45] which in order to find out more about the truth of

the student learning outcomes obtained, it is necessary to test using statistical formulas with normality and homogeneity tests [46]. Which can be seen in Table 4.

Table 4 . Normalization test of control and experiment class groups

| Group | df | Sig  |
|-------|----|------|
| A     | 35 | 0.48 |
| B     | 36 | 0.11 |

In Table 4, the normality test values are obtained by using IBM SPSS version 26 where a data is said to be homogeneous if the significance value is  $>0.05$  and if the significance value is  $<0.05$  then the data can be said to be non-homogeneous [47]. In Table 4, the sig. value is obtained. equal to 0.48 and 0.11 which is more than 0.05 which can be concluded that the data obtained in this study is significant or homogeneous. Like the research conducted by Evci *et al.* [48] regarding the effectiveness of using the module in learning where the significance value obtained is 0.385 which is greater than 0.05 which can be concluded that the data obtained is the same or homogeneous and in research conducted by Jokanović [49] which in this study also discussed the effectiveness of using modules in the learning process which in this study obtained a significance value of 0.014 greater than 0.005 and it can be said that the data obtained was homogeneous and there was an effect of using learning modules on increasing student knowledge.

Generally speaking, student satisfaction plays a significant role in determining learning results [3]. Compared to oral lectures or presentations using photos and photographs, the hologram's benefits allow visualization in a way that makes students feel as though they are there, which aids in their deeper understanding of a subject [50]. The positives are the results of using holograms, at a secondary level, as they draw students' interest, pique their engagement, and encourage teacher-student interaction, all of which eventually result in successful learning outcomes [1]. The education industry now has exciting new opportunities because to developments in digital holographic technology that push the limits of time and space through improved virtual presence and engagement [4]. After the data were obtained with a fair distribution, then an independent t-test was run in order to determine whether there were any notable differences between the study and the control group. Table 5 shows the N-Gain findings for the pre-test and post-test on student learning outcomes using the SPSS version 26 tool.

Table 5 . Independent t-test results for class A and B

| Variable                    | Levene's test for equality of variances | T-test for equality of means |                 |
|-----------------------------|---|------------------------------|-----------------|
|                             | Sig.                                    | df                           | Sig. (2-tailed) |
| Equal variances assumed     | 0.63                                    | 60                           | 0.001           |
| Equal variances not assumed |   | 58,261                       | 0.001           |

Based on Table 5, the findings of the independent t-test, where sig. Levene's test for equality of variances has a value of  $0.63 > 0.05$ , were discovered. This suggests that the data variance between classes A and B is comparable to or the same. Additionally, it can be deduced from this table that  $H_0$  is rejected and  $H_a$  is accepted for the sig. (2-tailed) of  $0.001 < 0.05$ . Therefore, it can be argued that there are disparities between group A (the control class) and group B (the experimental class) in the N-Gain findings of the student learning outcomes. From the results of the table it is clear that using hologram media can increase student activity because the learning process refers to students so that students understand and this can overcome existing misconceptions. Understanding students find that the learning process also runs contextually and it is real that this causes memory and the learning process to be effective. In addition, this is also a new and unique learning by using holographic media, this provides curiosity and enthusiasm for learning so that it focuses on the learning process. Focus in the learning process will produce a good and quality understanding, so that the problem of learning loss can be resolved quite well and effectively. Similar to the previous research conducted by Risdianto *et al.* [51], that there is a significant difference in learning outcomes from the pretest and posttest because this study's sig. (2-tailed) result was 0.000. Up to 40% of the 30 total students had pretest scores that were higher than the minimum completeness criteria, and up to 93.3% of those same students had posttest scores that were higher than the minimum completeness criteria. Consequently, the science module is successful in enhancing students' academic performance [52]. Furthermore, the research conducted by Zhang *et al.* [53] regarding the effectiveness of using learning modules where in this study the t-count was greater than the t-table, namely  $17.77 > 2.86$ , so  $H_0$  was rejected and  $H_a$  could be accepted. So it can be concluded from several previous research that the use of media is clearly able to overcome the problem of learning loss in schools.

#### 4. CONCLUSION

After a series of procedures were carried out in testing the effectiveness of using the hologram-based module which was applied to the control class which obtained an N-gain of 0.27 in the low category and in the experimental class an n-gain of 0.57 was obtained in the medium category. And in this research found significant differences in posttest results to determine student learning outcomes which can be proven by the independent t-test seen in sig. (2-tailed) of  $0.001 < 0.05$ , so that the collection of decisions in the independent t-test can be concluded that the use of hologram-based media is effective in overcoming learning loss.

It is hoped that this hologram- module product can be further developed and disseminated and practiced in schools by teachers to create student-centered learning. In the aspect of education policy makers, of course there is a need for guidance and support for teachers to be able to ensure that a teacher is able to produce interesting learning media and use learning media as an alternative to using holographic media. So it is hoped that research like this can have implications for society through real student-centered education so that students can face the challenges of the 21st century.

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#### AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualization

M : **M**ethodology

So : **S**oftware

Va : **V**alidation

Fo : **F**ormal analysis

I : **I**nvestigation

R : **R**esources

D : **D**ata Curation

O : Writing - **O**riginal Draft

E : Writing - Review & **E**ding

Vi : **V**isualization

Su : **S**upervision

P : **P**roject administration

Fu : **F**unding acquisition

#### CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest regarding the publication of this research. The funding provided by LPPM Universitas Islam Negeri Sultan Syarif Kasim Riau did not influence the design, execution, or interpretation of the study. All authors have contributed to the research and manuscript preparation independently, without any external pressures or competing interests. Additionally, no financial or personal relationships exist that could potentially bias the outcomes of this work.



## INFORMED CONSENT

Informed consent was obtained from all participants involved in this study. Prior to their participation, individuals were provided with comprehensive information about the research objectives, procedures, and potential benefits. They were assured of their right to withdraw from the study at any time without consequence. Additionally, confidentiality and anonymity were strictly maintained throughout the research process. Written consent was secured from all participants or, in the case of minors, from their legal guardians, as required by ethical guidelines.

## ETHICAL APPROVAL

This study was conducted in accordance with the ethical guidelines and standards set forth by Universitas Terbuka and relevant regulatory bodies. Ethical approval for this research was obtained from the Institutional Review Board (IRB) or Ethics Committee of LPPM Universitas Islam Negeri Sultan Syarif Kasim Riau, ensuring that all procedures adhered to ethical principles such as respect for persons, beneficence, and justice. The study design, data collection methods, and participant interactions were carefully reviewed to safeguard the rights, welfare, and privacy of all participants involved.

## DATA AVAILABILITY

The data supporting the findings of this study are available upon reasonable request. Restrictions may apply to the availability of certain datasets due to ethical or privacy considerations. Requests for access to the data should be directed to the corresponding author, [RV], who will ensure compliance with institutional policies and ethical guidelines. Additionally, any shared data will be anonymized to protect the privacy of participants.

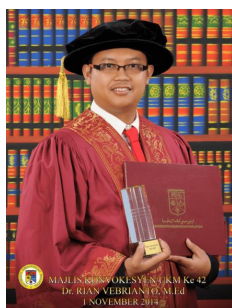
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