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The Effect of Cooperative Learning Model Type Student Team Achievement Divisions (STAD) Assisted by Virtual Media on Students' Concept Mastery Ability

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Abstract— This study aims to determine the effect of the Student Team Achievement Divisions (STAD) type cooperative learning model assisted by virtual media on students' concept mastery ability on static fluid material. The background of this study is based on the low level of mastery of students' concepts due to the dominance of conventional learning methods that lack interaction and the limited use of interactive learning media. This research is a quasi-experiment with a pretest-posttest control group design. The research subjects were students of class XI at SMAN 2 Mataram which were divided into experimental and control classes. The instrument used was a multiple choice test totaling 15 questions to measure concept mastery. The results showed that there was a significant increase in the posttest scores of students in the experimental class compared to the control class. The independent t-test showed a significance value <0.05, indicating a significant effect of the application of the STAD model assisted by virtual media on students' concept mastery. This finding shows that the combination of cooperative learning approach and virtual media such as PhET simulation and learning video is effective in increasing students' active participation, concept visualization, and understanding of physics materials.

Keywords— STAD Model; Virtual Media; Concept Mastery; PhET; Physics Learning

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1. Introduction

The 21st century demands a transformation in education that goes beyond mere mastery of academic content. In order to prepare students for success in an increasingly dynamic, digital, and globalized world, it is essential to cultivate higher-order thinking skills such as critical thinking, communication, collaboration, and creativity. These competencies, often referred to as the 4Cs, are considered core skills for 21st-century learners. Consequently, educators are expected to design and implement contextual, student-centered learning experiences that integrate technology meaningfully to help students meet the demands of global competition and lifelong learning [1].

Despite this vision, the practical implementation of such educational paradigms still faces numerous challenges, particularly in science education. In Indonesian high schools, the teaching of physics—a subject known for its abstract and conceptual nature—often continues to rely on conventional approaches. Teacher-centered instruction, dominated by lectures and textbook-based explanations, tends to limit student participation and engagement in the learning process. As a result, many students experience difficulty in understanding complex physics concepts and applying them in real-life contexts. The lack of interactive instructional media further exacerbates the issue, resulting in suboptimal learning outcomes and a persistent gap in conceptual mastery [2].

Physics, as a branch of science, involves the study of phenomena that are frequently invisible or difficult to observe directly, such as pressure, buoyancy, energy transfer, or fluid dynamics. Students must rely heavily on their ability to conceptualize and visualize these phenomena. Without adequate support through concrete representations or interactive media, these topics can appear disconnected from students' everyday experiences, thus diminishing their motivation and interest in learning physics. To address these obstacles, it is essential to adopt instructional strategies that not only promote student engagement but also provide visual and contextual representations of abstract concepts.

One promising instructional approach is the Student Team Achievement Divisions (STAD) model of cooperative learning. This model encourages students to work in heterogeneous teams where they collaborate to master the learning content and are rewarded based on the group's improvement and performance. STAD promotes social interaction, responsibility, and interdependence among group members, which can lead to improved academic achievement and a positive learning climate [3]. When combined with the integration of virtual learning media—such as PhET interactive simulations and educational videos—the STAD model offers an enriched learning environment that supports active participation, visual exploration, and deeper understanding. PhET simulations, developed by the University of Colorado, provide interactive, inquiry-based digital experiments that replicate real-world physics scenarios, allowing students to manipulate variables, observe outcomes, and draw conclusions based on their observations. Similarly, educational videos can present complex concepts through narration, animation, and real-life applications, making them more accessible and engaging to students [4].

An initial classroom observation conducted at SMAN 2 Mataram revealed that more than 50% of eleventh-grade students failed to achieve the minimum competency standard (*Kriteria Ketuntasan Minimal* or KKM) on the topic of static fluids. This outcome highlights a critical need for more effective instructional strategies that can foster meaningful learning and bridge the gap between abstract physics content and students' cognitive abilities. Given the potential of cooperative learning combined with virtual media to transform passive learning into active inquiry, the integration of the STAD model with tools like PhET simulations and educational videos is seen as a viable solution to enhance both student engagement and conceptual understanding [5].

Therefore, this study aims to investigate the effect of the STAD cooperative learning model supported by virtual media on students' conceptual understanding in physics, particularly on the topic of static fluids. By implementing a technology-integrated, collaborative learning approach, this research seeks to contribute to the development of innovative instructional practices that align with the goals of 21st-century education.

2. Literature Review

2.1. STAD Cooperative Learning Model

The Student Team Achievement Divisions (STAD) cooperative learning model is a form of group-based learning strategy developed by Robert Slavin in the context of cooperative learning theory. STAD is designed to improve students' conceptual understanding and academic achievement by encouraging collaboration among students in small, heterogeneous groups. Each group consists of members with different ability levels, where students are responsible not only for their own learning but also for the learning of their teammates [6].

Slavin (2005) outlines five key components in the STAD model: (1) class presentation, (2) group work, (3) individual quizzes, (4) individual improvement scores, and (5) team recognition [3]. The process begins with a class presentation delivered by the teacher to introduce the material to all students, usually using expository methods. This is followed by group work activities where students discuss the material collaboratively, help each other solve problems, and reinforce their understanding. After group work, students take individual quizzes without assistance to assess their mastery of the content. The scores are then compared to each student's previous performance to calculate an improvement score, and teams are given awards based on the cumulative progress of their members.

One of the strengths of the STAD model lies in its ability to foster an enjoyable and motivating classroom environment. Since the success of each team depends on the performance of every individual member, all students are encouraged to participate actively, support each other, and strive for both personal and collective improvement. This dynamic builds a sense of responsibility, belonging, and positive interdependence within the group [7]. Students take on the roles of peer tutors, engage in meaningful discussions, and develop essential interpersonal and academic skills in tandem.

The use of STAD in physics education is particularly beneficial, as it transforms the traditionally abstract and individual-centered learning process into one that is social, contextual, and learner-centered. By working in groups, students are exposed to multiple perspectives, which helps deepen their conceptual understanding. Furthermore, they are encouraged to communicate ideas, ask questions, and provide explanations—activities that are critical for developing higher-order thinking skills. This model also supports the notion of differentiated instruction, as students with higher abilities help others while reinforcing their own understanding, and those who struggle receive peer support in a non-threatening setting.

In addition, the model reflects the values of 21st-century education, which emphasizes not only cognitive achievement but also the cultivation of collaboration, empathy, communication, and mutual respect. STAD's emphasis on group recognition based on individual improvement motivates students across all ability levels, making it an inclusive model that values progress rather than just absolute performance [7]. This makes it highly adaptable to diverse classrooms, especially in the Indonesian education context, where variations in student abilities and learning styles are commonly found.

In sum, the STAD cooperative learning model provides a comprehensive instructional strategy that integrates cognitive, social, and motivational aspects of learning. When implemented effectively, it can serve as a powerful pedagogical tool for enhancing conceptual mastery, fostering student engagement, and cultivating collaborative skills necessary for lifelong learning.

2.2. Virtual Media

The term "media" is derived from the Latin word *medius*, meaning intermediary or channel. In the context of education, media refers to all tools, methods, or materials used by educators to convey messages in a planned and structured way to facilitate learning and improve its effectiveness [8]. Along with advances in information and communication technology, innovations in instructional media have also progressed significantly. One of the most notable developments is the emergence of virtual media, which leverages digital technology—particularly computers and the internet—to support interactive, student-centered learning environments. Examples of virtual media include interactive simulations, virtual laboratories, and educational videos.

In the teaching and learning of physics, virtual media offers a distinct advantage in presenting complex and abstract concepts that are often difficult to demonstrate directly in a classroom setting. Concepts such as pressure, buoyancy, energy conservation, and wave phenomena are often invisible to the naked eye and require students to engage in a high level of abstraction. Virtual media helps address this gap by providing visual and interactive representations through computer-based learning environments. One widely used form of virtual media is the virtual experiment, a simulation-based activity that replicates scientific investigations digitally. These virtual experiments provide opportunities for students to manipulate variables, observe results, and explore scientific principles at their own pace [9].

Interactive simulations such as PhET (Physics Education Technology) have proven to be particularly effective in supporting conceptual understanding. Developed by the University of Colorado, PhET simulations offer a collection of inquiry-based learning tools that present dynamic, real-time visualizations of physics concepts. The interactive nature of PhET allows students to actively experiment with variables, formulate hypotheses, and make sense of physical phenomena through exploration and discovery. These characteristics align closely with the principles of constructivist learning, in which knowledge is actively constructed by learners through meaningful engagement [10].

In addition to simulations, learning videos serve as powerful audiovisual tools that support the delivery of complex material in an engaging and comprehensible manner. Videos combine narration, images, animations, and real-life contexts to enhance comprehension and retention. According to Sitinjak (2022), learning videos can increase student concentration, improve attention span, and facilitate long-term memory by involving both visual and auditory channels [11]. They also offer flexibility for students to review material repeatedly at their own pace, thereby reinforcing learning outcomes.

The integration of virtual media in learning activities not only enhances understanding but also fosters an active and engaging classroom environment. Students become participants in their own learning process—making observations, conducting virtual experiments, and discussing findings in groups. These interactions encourage self-directed learning, boost confidence, and improve collaborative skills, all of which are essential in the development of 21st-century competencies [9].

In summary, virtual media plays a critical role in bridging the gap between abstract theoretical concepts and real-world applications in physics education. Its ability to visualize complex phenomena, facilitate inquiry-based learning, and support individual exploration makes it a valuable component of modern instructional strategies. When integrated thoughtfully, virtual media can transform the traditional classroom into an interactive, student-centered learning space that promotes deeper conceptual mastery and lifelong learning skills.

2.3. PhET Simulation and Learning Video

Among the various forms of virtual media, PhET interactive simulations and learning videos stand out as particularly effective tools for supporting physics education. Both serve as concrete applications of digital learning technologies, offering dynamic, visual, and interactive experiences that help students grasp abstract physics concepts more intuitively. These media respond to the challenges often faced in conventional physics instruction, where the content is heavily theoretical and difficult to visualize without concrete representations.

PhET (Physics Education Technology), developed by the University of Colorado, is a computer-based educational platform that provides a wide range of simulations in science, including physics, chemistry, and mathematics. In physics learning, PhET simulations enable students to conduct virtual experiments using interactive elements such as rulers, stopwatches, voltmeters, and variable sliders. These simulations mirror real-life laboratory scenarios, making it possible for students to observe and manipulate phenomena such as particle motion, electric circuits, wave interference, and fluid pressure—many of which are difficult or even impossible to demonstrate in a traditional classroom or school laboratory setting [12].

A key strength of PhET simulations lies in their alignment with constructivist learning theory, which emphasizes the active role of learners in constructing their own knowledge. According to Putranta et al. (2019), the use of PhET supports this paradigm by promoting student-driven exploration, experimentation, and reflection, thereby fostering deeper conceptual understanding [13]. Students are not merely passive recipients of information, but rather active participants who engage with the content, test hypotheses, and derive conclusions based on their virtual observations. This process not only enhances academic performance but also cultivates scientific thinking and inquiry skills. Furthermore, PhET simulations are accessible online, allowing for flexible, self-paced learning both inside and outside the classroom [14].

In parallel with simulations, learning videos have also proven to be an effective medium in delivering complex scientific content. As audiovisual media, learning videos present material through narration, animations, dynamic visuals, and often real-world demonstrations. They are particularly valuable in breaking down abstract or multilayered concepts into structured, visually engaging segments that facilitate student comprehension. Sitinjak (2022) asserts that the dual-channel processing of audio and visual inputs enables students to better retain information, as more cognitive pathways are activated in the learning process [11].

The benefits of learning videos extend beyond comprehension. These tools also support differentiated instruction and autonomous learning, allowing students to revisit the material as needed at their own pace. Videos empower teachers to present content in a more varied and contextually relevant manner, adapting to the diverse learning styles found in modern classrooms. According to Agustini and Ngarti (2020), the use of instructional videos can significantly increase student motivation and focus, leading to a more enjoyable and productive learning experience [5].

Together, PhET simulations and learning videos provide a synergistic approach to science instruction. While simulations offer interactive and experimental engagement, videos provide narrative and contextual clarity. Their combined use creates a multimodal learning environment that not only supports conceptual understanding but also fosters independent learning habits, critical thinking, and digital literacy. In physics education, where the abstract nature of the subject often presents learning barriers, these media serve as invaluable tools for transforming theory into tangible experience.

Therefore, integrating PhET simulations and learning videos into physics instruction can significantly enhance student engagement, improve understanding of key concepts, and support the achievement of more meaningful and long-lasting learning outcomes.

2.4. Concept Mastery Ability

Concept mastery is one of the fundamental goals in the learning process, particularly in science disciplines such as physics, where understanding is built upon a framework of interrelated principles and abstract constructs. It refers to the ability of learners to comprehend, explain, and apply learned concepts both theoretically and within real-world contexts using their own language and reasoning [15]. This skill reflects not only knowledge retention but also depth of understanding and the capacity for transfer of learning.

In the context of physics learning, concept mastery holds a critical role, as physics involves numerous abstract and often non-intuitive ideas that are essential for interpreting natural phenomena and solving scientific problems. Concepts such as force, energy, pressure, and motion are foundational but require cognitive abstraction, visualization, and analytical thinking to be fully understood. As Arisanti (2019) emphasized, concept mastery serves as a key indicator of student success in physics education, as it encompasses more than the memorization of formulas, it requires a meaningful grasp of the underlying principles and their real-life applications [16].

To assess concept mastery comprehensively, Anderson and Krathwohl (2001) proposed a revised taxonomy of the cognitive domain, which classifies cognitive abilities into six hierarchical levels: remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6). These levels represent progressively complex and deeper levels of thinking and comprehension, and they are widely used as a framework for formulating learning objectives and assessments in science education [17]. Effective physics instruction, therefore, should aim to guide students beyond basic recall, encouraging them to analyze problems, evaluate solutions, and generate novel ideas.

Empirical research supports the importance of concept mastery in facilitating broader cognitive skills. A study by Syahfira (2021) indicates that students with strong conceptual understanding tend to exhibit higher-order thinking abilities, greater problem-solving proficiency, and better contextual reasoning, enabling them to relate physics concepts to everyday experiences [18]. These abilities are essential not only for academic achievement but also for scientific literacy and critical decision-making in daily life. Complementing this, Nurita (2022) highlighted the relationship between concept mastery and students' scientific skills, including communication, reasoning, and collaborative learning. Students who understand concepts deeply tend to engage more confidently in classroom discussions, ask critical questions, and contribute actively to group activities, all of which are vital aspects of science education [19].

concept mastery encompasses more than theoretical knowledge—it includes the integration of critical, creative, and applied thinking skills. Therefore, instructional approaches and learning media must be strategically designed to foster these abilities. Learning environments that support inquiry, collaboration, and visualization—such as those using cooperative models and interactive virtual media—are better positioned to help students construct meaningful, contextual, and lasting understandings of physics concepts.

3. Methodology

This study used a quasi-experimental approach with a pretest-posttest control group design, which is commonly used to compare two groups under different conditions that are treated but not randomly selected [20]. This design involves two groups each given an initial test and a final test, with different treatments between them. The experimental group used the Student Team Achievement Divisions (STAD) type cooperative learning model assisted by virtual media, while the control group used conventional learning methods in the form of lectures.

The research was conducted at SMAN 2 Mataram in the even semester of the 2024/2025 academic year. The research subjects consisted of students of class XI Phase F which was divided into two classes: class XI Science 7 as the control class and class XI Science 8 as the experimental class, each consisting of 36 students. The sampling technique used was purposive sampling, which is a sample selection technique with certain considerations such as the similarity of the number of students and teaching teachers [21].

The main instrument used in this study was a concept mastery test in the form of 15 multiple choice questions prepared based on cognitive indicators in Bloom's taxonomy revised by Anderson and Krathwohl, covering C1 to C6 [17].

The instrument has gone through a trial stage which includes validity, reliability, difficulty level, and differential power tests, using a statistical approach with the help of SPSS version 25. The trial results show that the 15 questions are valid and reliable, with variations in difficulty levels from easy to difficult, and the differential power of questions which are generally in the good category [22].

The research procedure was carried out in three stages, namely planning, implementation, and evaluation. In the planning stage, researchers compiled learning tools in the form of teaching modules, LKPD, learning video media, and PhET simulations. In the implementation stage, both classes were given a pretest, then learning was carried out according to the treatment of each class, and ended with a posttest. In its implementation, the experimental class used interactive media such as PhET and learning videos integrated in STAD group activities, while the control class used lectures without interactive media [4].

Data from pretest and posttest results were analyzed using inferential statistical techniques. Prerequisite tests including normality and homogeneity tests were carried out first, and the results showed that the data were normally distributed and homogeneous. Therefore, hypothesis testing was carried out using an independent sample t-test to determine whether there was a significant difference between the experimental class and the control class on students' concept mastery [24].

As demonstrated in this document, the numbering for sections upper case Arabic numerals, then upper case Arabic numerals, separated by periods. Initial paragraphs after title are not indented. Only the initial, introductory paragraph has drop cap.

4. Results and Discussion

The concept mastery test tested as many as 20 items of multiple choice questions. The results of the concept mastery instrument analysis can be seen in table 4.2 as follows. The results of the analysis of concept mastery question items obtained that there were 15 valid question items and 5 invalid question items, namely question numbers 5, 10, 11, 15 and 17. The reliability test shows that all questions are reliable and for the level of difficulty of concept mastery questions, it is known that two questions are included in the difficult category, namely question items number 16, and 18, three questions in the medium category, namely question items number 4, 8, and 12, and ten questions in the easy category, namely question items number 1, 2, 3, 5, 6, 7, 13, 14, 19 and 20.

Table 1. Test Results of Concept Mastery Ability Instrument

Validity		Reliability		Difficulty Level		Item Discrimination	
Valid	15 items	Reliable	15 items	Hard	2 items	Very Good	0 items
Invalid	5 items	Not Reliable	0 items	Medium	3 items	Good	11 items
				Easy	10 items	Fair	4 items
						Poor	0 items

This study aims to determine the effect of the Student Team Achievement Divisions (STAD) type cooperative learning model assisted by virtual media on students' concept mastery ability on static fluid material. The results of the study were obtained from pretest and posttest scores which were analyzed using an independent t-test.

Table 2. Concept Mastery Pre-test Results

Class	N	Highest Score	Lowest Score	Average
Experiment	36	87	40	59,06
Control	36	73	33	55,36

Table 3. Concept Mastery Post-test Results

Class	N	Highest Score	Lowest Score	Average
Experiment	36	100	60	83,50
Control	36	93	40	61,08

Based on the pretest results, the average concept mastery score of students in the experimental class was 59.06, while in the control class was 55.36. This value shows that the initial ability of the two groups is relatively comparable and is below the Minimum Completion Criteria (KKM) of 80. After treatment, the posttest results showed a significant increase in the experimental class with an average score of 83.50, while the control class only reached an average of 61.08. This shows that the experimental class experienced a higher increase than the control class.

The data in Table 4.3 shows that the results of the average value in the experimental class are higher than the control class, with the average in the experimental class already meeting the KKM set by the school which is ≥ 80, and has increased compared to the pre-test value in terms of the highest value, lowest value, and average value. Comparison of the average pre-test and post-test of concept mastery can be seen in Figure 4.1.

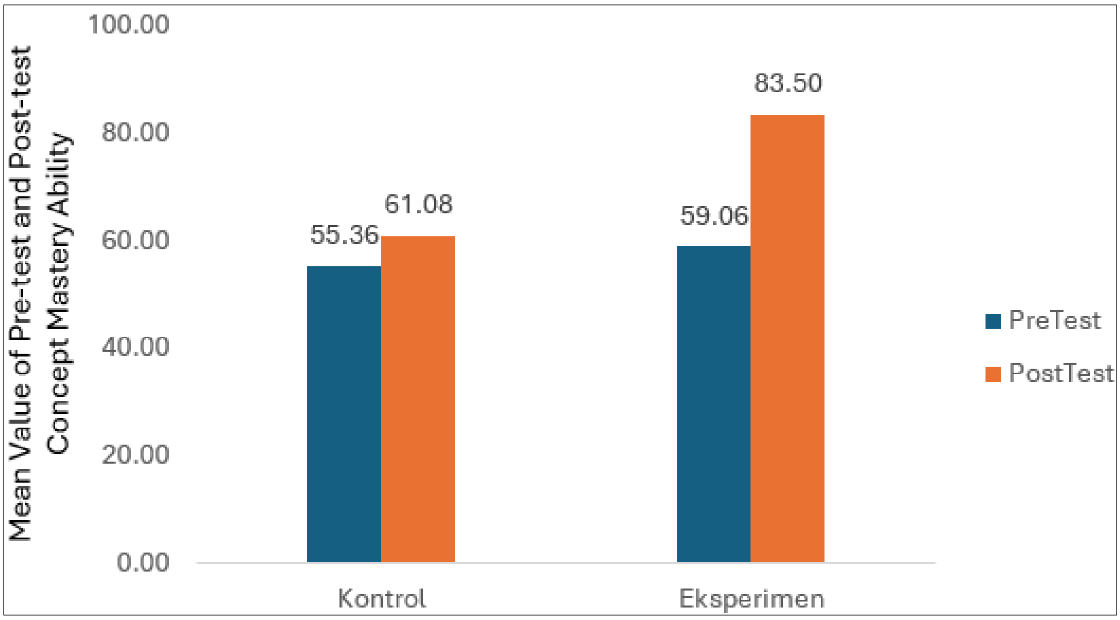

Fig 1. Comparison of Average Concept Mastery Score

The prerequisite test of the analysis was carried out to ensure that the data was normally distributed and homogeneous. The normality test results showed that the data from both classes were normally distributed with a significance value > 0.05. The homogeneity test results also showed that the variance between groups was homogeneous. Therefore, data analysis was continued with an independent t-test. The homogeneity test results in Table 4.4 and the normality test results can be seen in Table 4.5.

Table 4. Results of Homogeneity Test of Pre-test and Post-test of Concept Mastery

Ability	Class	N	Sig.	Description
Pre-test	Experiment	36	0,236	Homogenous
	Control	36	0,236	Homogenous
Post-test	Experiment	36	0,144	Homogenous
	Control	36	0,144	Homogenous

Table 5. Normality Test Results of Concept Mastery

Ability	Class	N	Sig.	Description
Pre-test	Experiment	36	0,069	Normally distributed
	Control	36	0,065	Normally distributed
Post-test	Experiment	36	0,082	Normally distributed
	Control	36	0,197	Normally distributed

The t-test results showed that there was a significant difference between the posttest results of the experimental class and the control class, with a significance value (p) < 0.05. This finding shows that the use of the STAD type cooperative learning model assisted by virtual media has a significant effect on improving students' concept mastery.

The increase in concept mastery in the experimental class can be explained by the STAD cooperative learning approach that allows students to help each other in understanding the material, as well as encouraging active involvement through group discussions. In addition, virtual media such as PhET simulations and learning videos provide strong visual support for understanding abstract concepts in physics. This media also allows students to conduct virtual experiments independently, so that learning becomes more meaningful and fun.

This finding is in line with research by Syahfira (2021) which shows that collaborative and interactive-based learning can improve students' conceptual understanding [18]. In addition, Doyan (2023) stated that the use of PhET media can increase students' motivation and learning outcomes because it allows direct exploration of physics concepts that are difficult to visualize in real [4].

Thus, the application of the STAD model assisted by virtual media proved effective in improving students' concept mastery ability. These results support the importance of integrating cooperative learning models and technology-based media in responding to 21st century learning challenges that demand active, collaborative, and critical thinking learners.

5. Discussion

This study shows that the application of the Student Team Achievement Divisions (STAD) type cooperative learning model assisted by virtual media can significantly improve students' concept mastery ability on static fluid material. This is evidenced by the difference in the average value of the posttest between the experimental class and the control class, as well as the t-test results which show significance <0.05. This finding strengthens the argument that the use of interactive and technology-based learning approaches can improve the quality of the teaching and learning process and student learning outcomes.

The significant improvement in the experimental class can be explained from two sides, namely the learning approach and the media used. In terms of approach, the STAD model facilitates students to learn actively through cooperation in small groups. This strategy encourages interaction between learners, where they discuss, explain and solve problems collectively. Slavin (2005) explains that STAD combines the value of competition and cooperation in learning, which can motivate learners to be actively involved and responsible for their own and their group's learning outcomes. This is in line with the characteristics of 21st century learning that emphasizes collaboration, communication, and individual responsibility in teams [3].

In terms of media, the use of virtual media such as PhET simulations and learning videos makes an important contribution in improving learners' understanding. PhET simulations provide interactive visualizations that allow learners to explore abstract physics concepts, such as Pascal's law, hydrostatic pressure, and Archimedes' principle. The simulation is designed to resemble a virtual laboratory with features that support variable manipulation and direct observation of results. Thus, students not only memorize formulas, but also understand the relationship between variables visually and contextually. This is in accordance with Doyan's research (2023) which states that PhET simulations help learners build conceptual understanding because they are exploratory and allow discovery-based independent learning [4].

In addition to simulation, the learning video used in this study also plays a role in increasing attention, information retention, and understanding of the material by students. Learning videos allow for a more systematic and engaging delivery of material through a combination of sound, images, animation, and narration. According to Sitinjak (2022), video media is very effective in conveying complex information because it involves the senses of hearing and vision simultaneously, which is proven to be able to improve learners' memory [11]. In this context, video media supports visual-auditory learning activities and provides flexibility for learners to re-access materials independently if needed.

The learning that took place in the experimental class was active, collaborative and learner-centered. This contrasts with learning in the control class which still uses the conventional lecture method. In the lecture method, interaction is one-way and learners tend to be passive. This condition can limit the knowledge construction process and reduce learners' involvement in understanding physics concepts. As a result, the increase in learning outcomes in the control class was not as optimal as the experimental class, as seen from the lower average posttest.

Theoretically, the results of this study support constructivism learning theory which emphasizes that learners construct their own knowledge through meaningful and interactive learning experiences. Through the STAD model and virtual media, learners are actively involved in the process of exploration, discussion, and reflection, so that learning becomes deeper and contextualized. In addition, this approach also supports the development of learners' critical thinking, problem solving and communication skills - core competencies needed to face global and technological challenges.

This research is also in line with Syahfira's (2021) findings, which showed that students who participated in group-based learning and technology had better concept mastery and thinking skills compared to students who learned individually and passively [18]. This shows that combining a collaborative learning approach with technological support such as virtual media is the right strategy in improving the quality of education, especially in science subjects that require in-depth understanding of concepts and applications.

Thus, the application of STAD model assisted by virtual media not only contributes to the improvement of cognitive learning outcomes, but also supports the formation of a collaborative learning environment, fun, and in accordance with the learning needs of the digital generation. The integration between learning methods and technology is an important element in reforming physics learning that is effective and relevant to the times.

6. Conclusion

Based on the results of the research and discussion that has been carried out, it can be concluded that the application of the Student Team Achievement Divisions (STAD) type cooperative learning model assisted by virtual media has a significant effect on improving students' concept mastery ability on static fluid material. This is indicated by an increase in posttest scores that are higher in the experimental class than the control class, as well as t-test results that show significant differences between the two groups.

The STAD model allows students to learn actively and collaboratively through group work, discussion, and individual responsibility, which encourages more involvement in the learning process. Meanwhile, virtual media such as PhET simulation and learning videos support visualization and exploration of abstract concepts in physics, thus helping learners build better conceptual understanding.

The integration of cooperative learning approach and technology-based media is proven to be able to create learning that is more effective, interesting, and relevant to the needs of 21st century learners. Thus, the STAD learning model assisted by virtual media is recommended as an alternative innovative and applicable physics learning strategy in improving students' learning outcomes.

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