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Implementation of Cooperative Learning Model Three Stay Two Stray Assisted by ARaRaT to Reduce Students' Misconceptions on Fluid Dynamic Material

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Abstract

This research aims to identify a decrease in students' misconceptions about dynamic fluid material after learning is implemented Three Stay Two Stray (TSTS) with the help of ARaRaT in experimental and learning classes and TSTS in the control class. This research uses mixed methods with a research design embedded in an experimental design. The research sample involved 65 students (22 male and 43 female) in class XI MIPA at one of the public high schools in Cimahi City. The technique for collecting data on students' misconceptions used the test instrument Four-Tier Fluid Dynamic Concept (FT-FDC), which consists of 10 questions that are analyzed using the reducing quantity misconceptions equation to see the decrease in the number of students' misconceptions after being given treatment. The results of the data analysis in the experimental class showed a change in the percentage of students experiencing misconceptions from 38.8% to 10%, with an average decrease of 28.8%. Meanwhile, the percentage change in the number of students' misconceptions in the control class was obtained from 36.1% to 23.9%, with an average percentage decrease of 12.2%. This research implies that students become more skilful in conducting experiments with the help of ARaRaT and better understand concepts that are not only in the form of verbal statements but with various forms of representation of images, graphs, tables, mathematical equations, and even 3D media with the help of Augmented Reality. Thus, implementing TSTS learning assisted by ARaRaT can be an alternative to physics learning to reduce students' misconceptions.

Keywords: ARaRaT; fluid dynamics; misconceptions; three stay two stray

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INTRODUCTION

Learning physics and understanding concepts are two things that are interrelated and cannot be separated. In the learning process, there is often a gap between students' understanding of concepts because students generally bring initial knowledge from daily experiences and information from the surrounding environment, which is often referred to as students' initial understanding (Kaniawati et al., 2019; Samsudin et al., 2018; Tompo et al., 2016; Kaniawati et al., 2021). Students come to class with knowledge that may or may not conform to scientific conceptions (Koba & Tweed, 2009; Parker et al., 2012; Svandova, 2013; Sesen, 2013; Kibirige et al., 2014). Sometimes students' initial

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understanding is not in line with scientific concepts. In physics, accurate concepts refer to the conceptions of physical scientists (Adimayuda et al., 2020; Aminudin et al., 2019; Nuzulira et al., 2020; Kaniawati et al., 2021). However, in practice, many students face difficulties in understanding physics concepts, resulting in differences in the concepts held by students and physical scientists. This situation is known as a misconception. Misconceptions can arise from various sources, including students, teachers, textbooks, learning contexts, and teaching methods (Irwansyah et al., 2018; Soeharto et al., 2019; Tumanggor et al., 2020; Kaniawati et al., 2021).

Based on literature studies, researchers found research that had previously used a three-tier diagnostic test, with the result that 65.32% of students experienced misconceptions about dynamic fluid material (Saputra et al., 2019). Furthermore, in other research, by applying diagnostic tests four-tiered (Aprita et al., 2018), the results obtained showed that 29.21% of students experienced misconceptions about dynamic fluid material.

Apart from being based on literature studies, a preliminary study was also carried out at one of the high schools in Bandung City through interviews with physics teachers and tests for one of the XII MIPA classes to identify misconceptions about fluid dynamic material. The results of a preliminary study through interviews with physics teachers showed that physics learning often uses teacher-centered methods. This causes students to become less active and feel bored during physics learning because it is considered difficult, so many experience misconceptions, especially regarding fluid dynamic material. Several problems, such as students' lack of understanding and misconceptions during classroom learning, have not fully facilitated students' progress, as can be seen from the average daily test results on dynamic fluid material, which has not reached the minimum completion criteria.

Apart from that, based on the results of a preliminary study using tests, researchers obtained data showing that the average percentage of misconceptions experienced by students in dynamic fluid material was 47%. This shows that based on the results of the tests carried out, many students still experience misconceptions, especially regarding dynamic fluid material. The misconceptions that occur include several sub-concepts, namely the ideal fluid sub-concept at 38%, the principle of continuity sub-concept at 54%, and the Bernoulli principle sub-concept at 49%. A total of 32 students from class XII MIPA who have studied dynamic fluid material participated in filling out a diagnostic test instrument in the form of a four-tier test of dynamic fluids consisting of 10 items adapted from previous research. The percentage of students' misconceptions of the dynamic fluid sub-concept obtained during the preliminary study is represented in the bar chart in Figure 1.

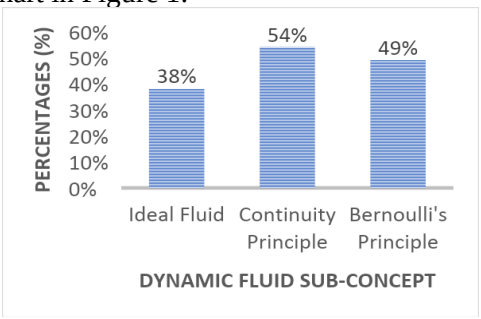


Figure 1 Percentage of students misconceptions on the dynamic fluid sub-concept

Based on Figure 1, information was obtained that the test instrument used during the preliminary study consisted of three dynamic fluid sub-concepts. The first sub-concept is the ideal fluid, represented by two questions, and the average percentage of student misconceptions is 38%. The second sub-concept is the principle of continuity which is represented by five questions with an average

percentage of student misconceptions of 54%. The next sub-concept is the Bernoulli principle which is represented by three questions with an average percentage of student misconceptions of 49%. Thus, the average percentage of students' misconceptions regarding all sub-concepts is 47%.

When misconceptions occur, they will hinder the process of understanding further concepts. Teachers must know what students think and know about concepts, some of which may conflict with scientific concepts. . Therefore, these misconceptions must be addressed immediately. Effective and efficient learning solutions are needed to reduce misconceptions (Akmam et al., 2018; Astiti et al., 2020; Ling, 2017; Kaniawati et al., 2021). One learning model that can be applied is the learning model Three Stay Two Stray (TSTS) with the use of media augmented reality and rebuttal text (ARaRaT).

The TSTS type cooperative learning model is one type of development of the Two Stay Two Stray type cooperative learning model (Ariyani et al., 2017; Arzak & Ibrahim, 2017). In the three Stay Two Stray learning model, students study in small groups where each member has varying ability levels. The development of the TSTS learning model lies in the number of group members consisting of five members with different concept understanding abilities so that students can help each other understand the learning material. The TSTS model has the advantage that students will be actively involved in the learning process, and in the group, all members are required to report the results obtained so that it can have the effect of increasing learning outcomes and memory (Manik & Gafur, 2016). The existence of small group learning in TSTS learning is expected to allow students to work together to solve problems in terms of finding concept understanding (Asmawati & Wuryanto, 2014). To increase the effectiveness of the cooperative type of learning model Stay Two Stray For more optimal results, steps are needed to reduce misconceptions and increase students' understanding of concepts so that they become more scientific by packaging learning activities in more interesting ways. One strategy that can be used is to utilize Augmented Reality (AR) learning media integrated with rebuttal text (Samsudin et al., 2021).

Education in this century is education that is closely related to technology, especially the application of technology for learning media. Technology development in education has produced many new innovations to support the learning process (Anggraeni, 2018). One of them is the increasing number of variations of learning media thanks to increasingly rapid technological development (Megahantara, 2017). Utilization of media AR has the potential to be an alternative learning media in the current digital era. Students need innovation, so they are not only fixated on conventional learning media. Students expect learning media that are interesting, easy to understand, user-friendly and encourage active participation in the learning process. Digital media that attract students' interest can effectively overcome misconceptions (Samsudin et al., 2017; Samsudin, et al., 2021). Using simulations in media also allows students to conduct investigations more interactively (Jiang et al., 2018; Samsudin et al., 2021). Interactive media provides learning material with a more attractive and informative appearance to optimize learning (Wiana, 2018). By integrating graphics, text, videos, simulations, animations, and images, the media can simulate various experiments, physics phenomena, and processes. The content taught becomes more attractive, can increase students' participation in the learning process, and improves understanding of physics concepts (Jian-hua & Hong, 2012). Implementing AR in the learning process increases the effectiveness of learning that focuses on students and increases the effectiveness of cooperative learning activities. Thus,

implementing AR is expected to create a more interesting and significant learning process for students (Mustaqim, I., 2017).

A rebuttal text is a text that refutes alternative conceptions. Several studies have shown that refutation texts can help students understand a concept (Caleon & Subramaniam, 2013; Kendeou & Van Den Broek, 2007; Nussbaum et al., 2017; Samsudin et al., 2021; Will et al., 2019). Therefore, the solution taken in this research is to apply a cooperative learning model TSTS-assisted ARaRaT to reduce misconceptions. From this explanation, the research framework can be described as shown in Figure 2.

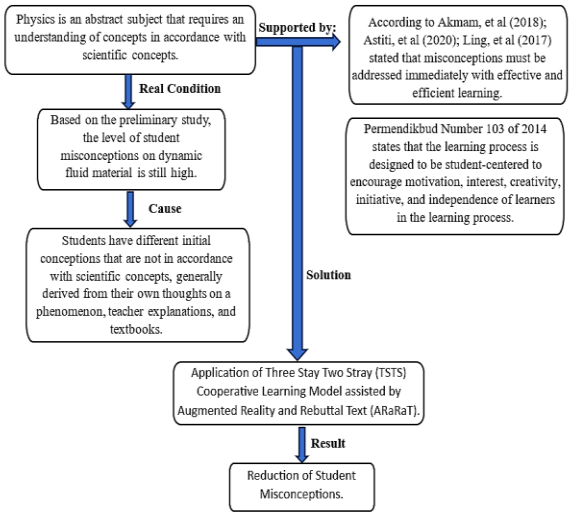


Figure 2. Research framework

METHOD

This research aims to reduce students' misconceptions about dynamic fluid material through the implementation of a learning model, Three Stay Two Stray (TSTS), assisted by ARaRaT. The research was conducted using mixed methods (mixed methods) with a research design embedded in an experimental design. Mixed methods are procedures for collecting, analyzing, and integrating quantitative and qualitative data in a single study (Creswell, 2012).

Participants

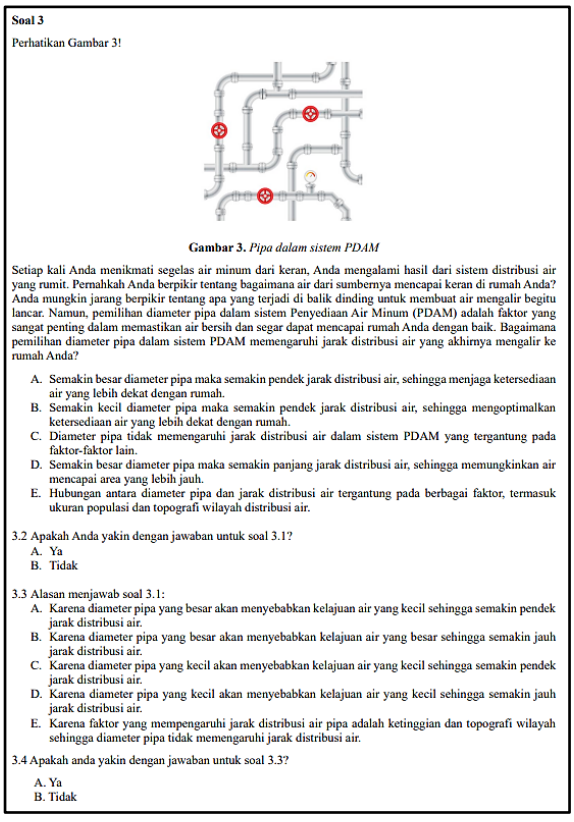
The research was carried out at a public high school in Cimahi City, West Java. The map of the research location is shown in Figure 3

Figure 3 Research location map
Source: bing.com/maps

The population in this study were all students in phase for class XI MIPA at one of the state high schools in Cimahi City. Meanwhile, the samples in this study were two classes from the entire population. The sampling technique used is purposive sampling based on certain considerations based on the criteria and research objectives.

Instruments

The method used to identify students who experience misconceptions is to use diagnostic tests (Saputri & Kurniawan, 2021; Rahmita & Wasis, 2022). Diagnostic tests determine students' difficulties in understanding concepts (Gurel et al., 2015). Diagnostic tests are assessment tools designed to show unresolved challenges or problems that students' may face in the learning process (Fariyani et al., 2017; Gurel et al., 2015; Pertiwi & Setyarsih, 2015; Rosita et al., 2020; Astuti et al., 2023). Thus, the existence of this diagnostic test is very helpful in identifying misconceptions that occur in students'. The instruments used in this research are a Four-Tier Fluid Dynamic Concept (FT-FDC) that consists of 10 questions. The preparation of the FT-FDC instrument uses a 4D model which includes four stages, namely, Define, Design, Develop, and Disseminate (Aripiani et al., 2023). Including reasons for choosing answers is an important improvement (Anggrayni & Ermawati, 2019; Hermita et al., 2017; Astuti et al., 2023). Therefore, the four-level multiple-choice diagnostic test is the most accurate for detecting misconceptions (Afif et al., 2017; Anggrayni & Ermawati, 2019; Hermita et al., 2017; Astuti et al., 2023). Figure 4 below shows an example of a question in the FT-FDC instrument.



Soal 3

Perhatikan Gambar 3!

Gambar 3. *Pipa dalam sistem PDAM*

Setiap kali Anda menikmati segelas air minum dari keran, Anda mengalami hasil dari sistem distribusi air yang rumit. Pernahkah Anda berpikir tentang bagaimana air dari sumbernya mencapai keran di rumah Anda? Anda mungkin jarang berpikir tentang apa yang terjadi di balik dinding untuk membuat air mengalir begitu lancar. Namun, pemilihan diameter pipa dalam sistem Penyediaan Air Minum (PDAM) adalah faktor yang sangat penting dalam memastikan air bersih dan segar dapat mencapai rumah Anda dengan baik. Bagaimana pemilihan diameter pipa dalam sistem PDAM memengaruhi jarak distribusi air yang akhirnya mengalir ke rumah Anda?

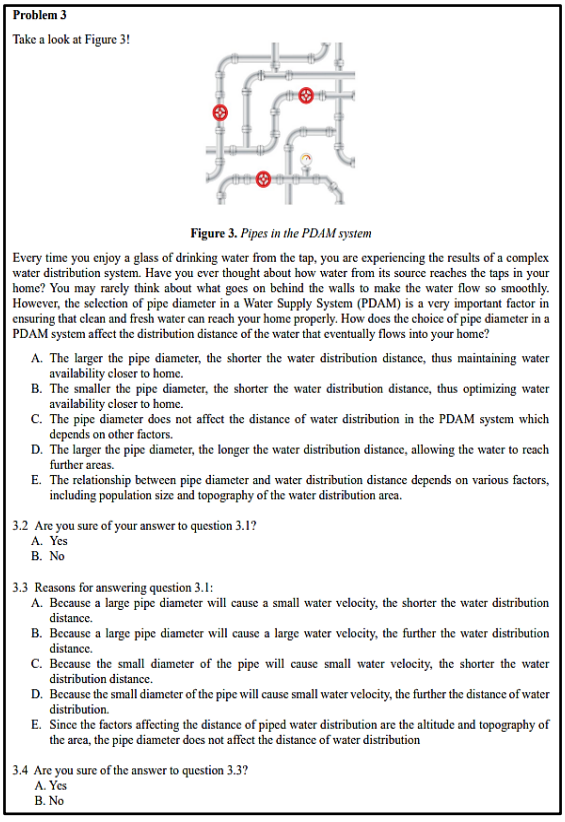
A. Semakin besar diameter pipa maka semakin pendek jarak distribusi air, sehingga menjaga ketersediaan air yang lebih dekat dengan rumah.
B. Semakin kecil diameter pipa maka semakin pendek jarak distribusi air, sehingga mengoptimalkan ketersediaan air yang lebih dekat dengan rumah.
C. Diameter pipa tidak memengaruhi jarak distribusi air dalam sistem PDAM yang tergantung pada faktor-faktor lain.
D. Semakin besar diameter pipa maka semakin panjang jarak distribusi air, sehingga memungkinkan air mencapai area yang lebih jauh.
E. Hubungan antara diameter pipa dan jarak distribusi air tergantung pada berbagai faktor, termasuk ukuran populasi dan topografi wilayah distribusi air.

3.2 Apakah Anda yakin dengan jawaban untuk soal 3.1?
A. Ya
B. Tidak

3.3 Alasan menjawab soal 3.1:
A. Karena diameter pipa yang besar akan menyebabkan kelajuan air yang kecil sehingga semakin pendek jarak distribusi air.
B. Karena diameter pipa yang besar akan menyebabkan kelajuan air yang besar sehingga semakin jauh jarak distribusi air.
C. Karena diameter pipa yang kecil akan menyebabkan kelajuan air yang kecil sehingga semakin pendek jarak distribusi air.
D. Karena diameter pipa yang kecil akan menyebabkan kelajuan air yang kecil sehingga semakin jauh jarak distribusi air.
E. Karena faktor yang mempengaruhi jarak distribusi air pipa adalah ketinggian dan topografi wilayah sehingga diameter pipa tidak memengaruhi jarak distribusi air.

3.4 Apakah anda yakin dengan jawaban untuk soal 3.3?
A. Ya
B. Tidak

(a) Responses sample of FT-FDC instrument



Problem 3

Take a look at Figure 3!

Figure 3. *Pipes in the PDAM system*

Every time you enjoy a glass of drinking water from the tap, you are experiencing the results of a complex water distribution system. Have you ever thought about how water from its source reaches the taps in your home? You may rarely think about what goes on behind the walls to make the water flow so smoothly. However, the selection of pipe diameter in a Water Supply System (PDAM) is a very important factor in ensuring that clean and fresh water can reach your home properly. How does the choice of pipe diameter in a PDAM system affect the distribution distance of the water that eventually flows into your home?

A. The larger the pipe diameter, the shorter the water distribution distance, thus maintaining water availability closer to home.
B. The smaller the pipe diameter, the shorter the water distribution distance, thus optimizing water availability closer to home.
C. The pipe diameter does not affect the distance of water distribution in the PDAM system which depends on other factors.
D. The larger the pipe diameter, the longer the water distribution distance, allowing the water to reach further areas.
E. The relationship between pipe diameter and water distribution distance depends on various factors, including population size and topography of the water distribution area.

3.2 Are you sure of your answer to question 3.1?
A. Yes
B. No

3.3 Reasons for answering question 3.1:
A. Because a large pipe diameter will cause a small water velocity, the shorter the water distribution distance.
B. Because a large pipe diameter will cause a large water velocity, the further the water distribution distance.
C. Because the small diameter of the pipe will cause small water velocity, the shorter the water distribution distance.
D. Because the small diameter of the pipe will cause small water velocity, the further the distance of water distribution.
E. Since the factors affecting the distance of piped water distribution are the altitude and topography of the area, the pipe diameter does not affect the distance of water distribution

3.4 Are you sure of the answer to question 3.3?
A. Yes
B. No

(b) Responses sample of FT-FDC instrument

Figure 4. Samples of FT-FDC instrument

Tier-1, in the form of multiple-choice questions, has five answer options. Tier-2 shows the level of confidence in the answer to tier-1. Tier-3 contains reasons in the form of multiple-choice questions for the answer choices in tier-1. Tier-4 shows the level of confidence in the reasons given in tier-3.

Data Analysis

The data collection technique used in this research is a measurement technique by administering diagnostic tests consisting of four-tier tests consisting of 10 questions. This test is given to students before it is given treatment (pre-test) and after given treatment (post-test). Data collected from the results of the diagnostic test identifies misconceptions experienced by students before and after it is given treatment. This data is mixed, which will then be processed for further analysis.

After obtaining the post-test students' results data, the next step is to process and analyze the data. This initial step is to group students' answers according to the conception criteria shown in Table 1.

Table 1 Students' conception criteria

Conception Criteria	Tier			
	1	2	3	4
Misconception (MC)	Wrong	Sure	Wrong	Sure
Sound Understanding (SU)	Correct	Sure	Correct	Sure
	Correct	Not Sure	Correct	Not Sure
	Correct	Sure	Correct	Not Sure
	Correct	Not Sure	Correct	Sure
	Correct	Not Sure	Wrong	Not Sure
	Wrong	Not Sure	Correct	Not Sure
Partial Understanding (PU)	Correct	Sure	Wrong	Not Sure
	Correct	Not Sure	Wrong	Sure
	Wrong	Sure	Correct	Not Sure
	Wrong	Not Sure	Correct	Sure
	Correct	Sure	Wrong	Sure
	Wrong	Sure	Correct	Sure
No Understanding (NU)	Wrong	Not Sure	Wrong	Not Sure
	Wrong	Sure	Wrong	Not Sure
	Wrong	Not Sure	Wrong	Sure
No Coding (NC)	If you do not fill in one or more items (levels)			

After grouping the data according to the conception criteria, the next step is calculating the percentage of students' answers. This aims to describe the misconceptions experienced by students using equation (1) proposed by (Samsudin, Aminudin et al., 2021), which can be formulated as follows.

$$CC(\%) = \frac{\sum conception\ criteria}{\sum total\ student} x100\% \quad \ldots (1)$$

Information:

CC : Conception criteria

After calculating the percentage of students' misconceptions, the next step is to calculate the percentage of students' misconceptions on each sub-concept using Equation (2).

$$R = \frac{\sum MC}{\sum S} x100\% \quad \ldots (2)$$

Information:

R : percentage of misconceptions for each sub-concept (%)

ΣMC : the number of students who fall into the category of each sub-concept

ΣS : the number of students who took the test

To determine the decrease in students' misconceptions after implementing learning Three Stay Two Stray (TSTS) assisted by ARaRaT by analyzing the results of pre-test and post-test students, which are calculated by adopting the DQM equation by (Kurniawan et al., 2016; Kurniawan et al., 2019) as shown in Equation (3).

$$DQM = \frac{\% < S_i > - \% < S_f >}{\% < S_i > - \%ideal} \quad \ldots (3)$$

Information:

$< DQM >$: average decrease in the quantity of misconceptions

$< \%S_i >$: average percentage of current

misconceptions pre-test
$< \%S_f >$: average percentage of current misconceptions post-test
%ideal : 0 (percentages of the number of students' misconception)

The DQM value calculation results were then interpreted using the criteria in Table 2.

Table 2 DQM score criteria

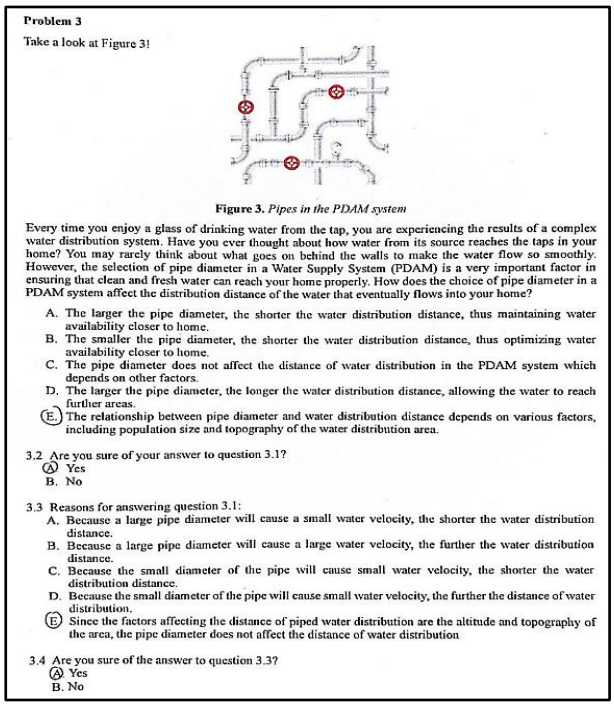
DQM Score	Interpretation
DQM > 0.7	High
0.3 ≤ DQM ≤ 0.7	Moderate
DQM < 0.3	Low

(Aminudin et al., 2019)

RESULT AND DISCUSSION

The model TSTS is one of the cooperative learning models used in this research, and it is then integrated with media ARaRaT. AR technology can make the learning process more flexible, interesting, and interactive, which can create active learning for students (Kusumoto, 2018). Augmented reality can potentially engage, inspire, and motivate students to explore and control it from a different perspective that was not previously considered in education (Hendriyani et al., 2019). With AR, physics learning can be done more realistically (Cai et al., 2017; Wang et al., 2018).

TSTS learning with ARaRaT consists of several syntaxes. The first syntax is that the teacher makes apperception and explains the learning objectives. Students are asked to identify the initial concept understanding and level of confidence by providing phenomena related to dynamic fluid material. In this syntax, the researcher discusses the findings of the pre-test and post-test. Then, in the second syntax, the researcher provides phenomena related to the material and encourages students to formulate problems in their way. In the third syntax, students are directed to do a practicum with the help of Ararat with their groups of five heterogeneously. Then, in the fourth syntax, each group analyzes and makes conclusions based on the practicum results. Finally, the fifth syntax is the confirmation and strengthening of conceptions obtained after group exploration. In Figure 5, the results of students' answers are shown To one of the questions in accordance with Figure 4.



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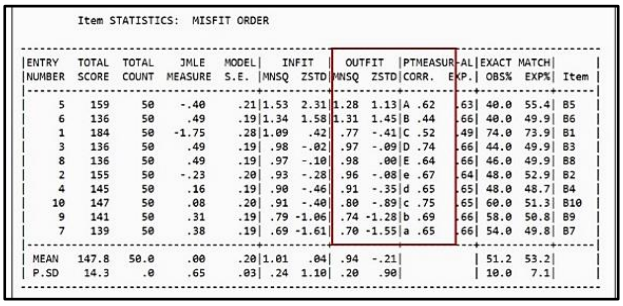
D. Because the small diameter of the pipe will cause small water velocity, the further the distance of water distribution.
(E) Since the factors affecting the distance of piped water distribution are the altitude and topography of the area, the pipe diameter does not affect the distance of water distribution

3.4 Are you sure of the answer to question 3.3?
(A) Yes
B. No

Figure 5 Example of students' answers

Figure 5 shows one example of the answer results pre-test depicted that students still experiences misconceptions in question number 3 with the sub-concept of the principle of continuity. There is a misconception among students in answering that there is no relationship between pipe diameter and water distribution distance.

In addition, before the FT-FDC instrument was used in research, researchers carried out an analysis using Rasch modeling-assisted software Ministep 5.6.1. This analysis aims to ensure the validity and reliability of each question item to determine the quality of the instrument. The results obtained regarding the validity of the FT-FDC instrument are presented in Figure 6.



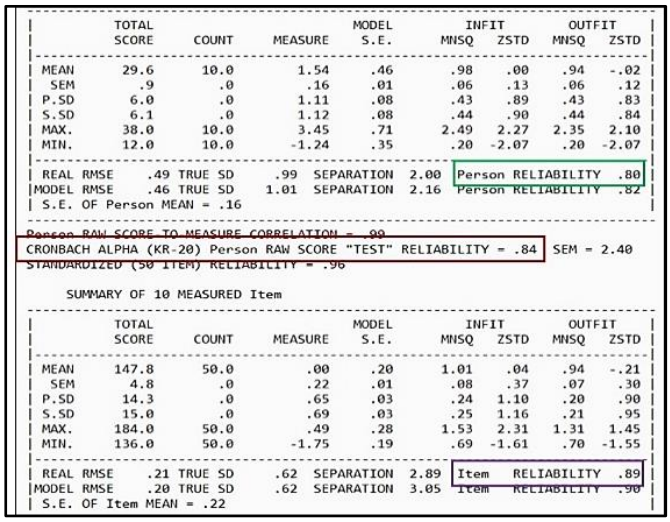
Item STATISTICS: MISFIT ORDER

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	JMLE MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEASUR-AL CORR.	PTMEASUR-AL EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item
5	159	50	-.40	.21	1.53	2.31	1.28	1.13	A .62	.63	40.0	55.4	B5
6	136	50	.49	.19	1.34	1.58	1.31	1.45	B .44	.66	40.0	49.9	B6
1	184	50	-1.75	.28	1.09	.42	.77	-.41	C .52	.49	74.0	73.9	B1
3	136	50	.49	.19	.98	-.02	.97	-.09	D .74	.66	44.0	49.9	B3
8	136	50	.49	.19	.97	-.10	.98	.00	E .64	.66	46.0	49.9	B8
2	155	50	-.23	.20	.93	-.28	.96	-.08	e .67	.64	48.0	52.9	B2
4	145	50	.16	.19	.90	-.46	.91	-.35	d .65	.65	48.0	48.7	B4
10	147	50	.08	.20	.91	-.40	.80	-.89	c .75	.65	60.0	51.3	B10
9	141	50	.31	.19	.79	-1.06	.74	-1.28	b .69	.66	58.0	50.8	B9
7	139	50	.38	.19	.69	-1.61	.70	-1.55	a .65	.66	54.0	49.8	B7
MEAN	147.8	50.0	.00	.20	1.01	.04	.94	-.21			51.2	53.2	
P.SD	14.3	.0	.65	.03	.24	1.10	.20	.90			10.0	7.1	

Figure 6 FT-FDC instrument validity test

The quality of each item is seen by reviewing the MNSQ outfit value, ZSTD outfit, and Pt Measure Corr with criteria referring to (Sumintono & Widhiarso, 2015) and then interpreted based on the fit-statistic value criteria (Sumintono et al., 2014). Based on Figure 6, information is obtained that overall, all the questions analyzed meet the criteria for grades Outfit MNSQ, ZSTD, dan Pt Measure Corr. Thus, it can be concluded that the ten items on the FT-FDC instrument are valid and can be used as instruments in research.

For reliability testing using Rasch modelling consists of person reliability, item reliability, and Cronbach's Alpha values. The results of the reliability test are presented in Figure 7.



	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	29.6	10.0	1.54	.46	.98	.00	.94	-.02
SEM	.9	.0	.16	.01	.06	.13	.06	.12
P.SD	6.0	.0	1.11	.08	.43	.89	.43	.83
S.SD	6.1	.0	1.12	.08	.44	.90	.44	.84
MAX.	38.0	10.0	3.45	.71	2.49	2.27	2.35	2.10
MIN.	12.0	10.0	-1.24	.35	.20	-2.07	.20	-2.07

REAL RMSE .49 TRUE SD .99 SEPARATION 2.00 Person RELIABILITY .80
MODEL RMSE .46 TRUE SD 1.01 SEPARATION 2.16 Person RELIABILITY .82
S.E. OF Person MEAN = .16

Person RAW SCORE-TO-MEASURE CORRELATION = .99
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .84 SEM = 2.40
STANDARDIZED (50 ITEM) RELIABILITY = .96

SUMMARY OF 10 MEASURED Item

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	147.8	50.0	.00	.20	1.01	.04	.94	-.21
SEM	4.8	.0	.22	.01	.08	.37	.07	.30
P.SD	14.3	.0	.65	.03	.24	1.10	.20	.90
S.SD	15.0	.0	.69	.03	.25	1.16	.21	.95
MAX.	184.0	50.0	.49	.28	1.53	2.31	1.31	1.45
MIN.	136.0	50.0	-1.75	.19	.69	-1.61	.70	-1.55

REAL RMSE .21 TRUE SD .62 SEPARATION 2.89 Item RELIABILITY .89
MODEL RMSE .20 TRUE SD .62 SEPARATION 3.05 Item RELIABILITY .90
S.E. OF Item MEAN = .22

Figure 7 Reliability test of FT-FDC instrument

Based on Figure 7, information is obtained that the results of the value reliability test person reliability value 0.80 with the interpretation "Enough". As for value item reliability of 0.89 with the interpretation "Good". This indicates that students' answer consistency is quite good, and the FT-FDC instrument is of good quality. Then for value Cronbach's alpha of 0.84 with the interpretation "Very high". Therefore, the instruments used show good consistency in data collection. Thus, the results of the instrument analysis show that the questions are of very good quality, so they are suitable for use in research. In this research, after analyzing students' misconceptions at the time of the pre-test, then the next step is for students to be given treatment so that they no longer experience misconceptions about a concept such as dynamic fluid material. In order to know the final conception of students after being given treatment, then implemented post-test. The increase in concept understanding reduces misconceptions because the TSTS model is one of cooperative learning. Various research results have shown that cooperative learning provides positive benefits for concept understanding and student learning outcomes. The following are the average student misconceptions and DQM scores in the experimental and classroom classes controls shown in Table 3.

Table 3 Average misconceptions of students on dynamic fluid material

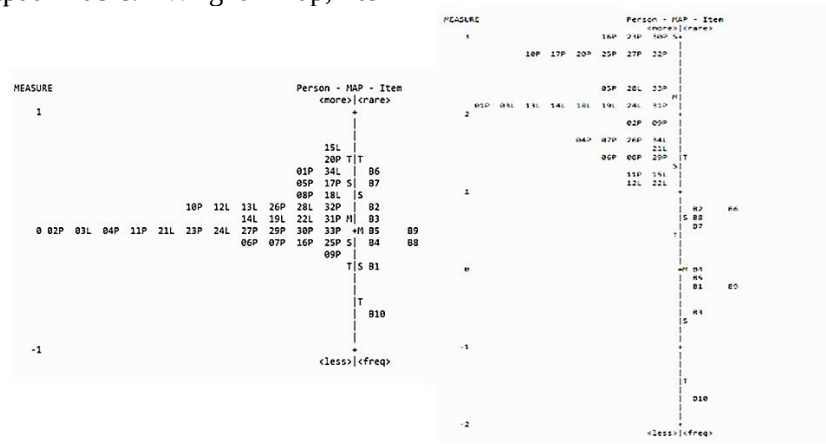
Class	Average		DQM	Interpretation
	Pre-test (%)	Post-test (%)		
Experimental	38.8	10	0.7	Moderate
Control	36.1	23.9	0.4	Moderate

The reduction in students' misconceptions before and after implementing learning in both classes can be seen from the DQM scores in Table 3 calculated using Equation (3) and interpreted using the criteria according to Aminudin et al. (2019) and Hamundu et al. (2023) as in Table 2. Based on Table 3, the analysis results show that the overall DQM value obtained from pre-test and post-test TSTS learning assisted by ARaRaT in the experimental class was 0.70 with the interpretation "Medium". Meanwhile, the DQM value obtained from the results of pre-test and post-test TSTS learning students in the control class was 0.40 with the interpretation of "Medium."

AR can help students understand abstract concepts or phenomena, and it can increase their interest in science by providing concrete knowledge in the field (Arici et al., 2019). The use of AR media allows learning content to be presented in a meaningful and concrete way.

The results of this data show that both learning models, the TSTS and TSTS learning models, are integrated with ARaRaT and can reduce students' misconceptions, but there are differences when viewed based on the DQM scores obtained in the two classes. The DQM scores obtained in classes that applied TSTS learning assisted by ARaRaT were higher than those that applied TSTS learning only. This shows that a learning model that is integrated with a method, approach, or learning support media can reduce misconceptions, thereby significantly increasing understanding of learning concepts. There are still students who experience misconceptions because it can be seen that the decrease is not too large. This is because misconceptions are not something that can be eliminated easily. Research conducted by (Kapartzianis & Kriek, 2014) showed that even though the students' misconceptions were reduced after learning with the cooperative learning model, the cooperative learning model can reduce the percentage of misconceptions.

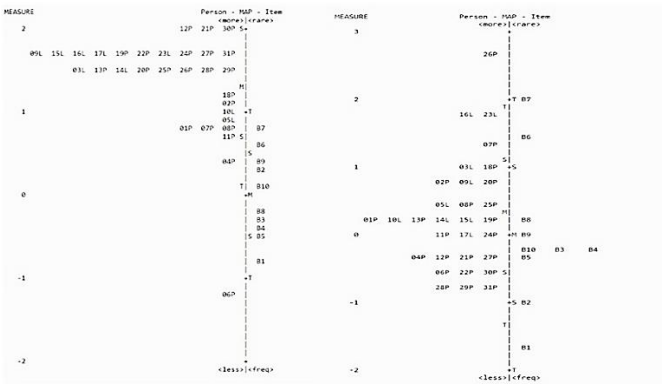
However, misconceptions were still found in a small percentage of students. Currently, pre-test and post-test can be processed using Rasch modelling analysis, as seen from the menu Output Table: Wright Map, to compare potential misconceptions. A comparison of potential misconceptions for the experimental class can be presented in Figure 8.



(a) Pre-test (b) Post-test

Figure 8 Comparison of potential misconceptions of experimental class students

Based on students' misconception scores, the students with codes 15L and 20P have the potential to answer the highest number of misconceptions because they are at the top. Meanwhile, students with code 09P have the potential to answer the lowest number of misconceptions because they are at the bottom of the list. This shows that all students have the potential to answer all questions with misconceptions. Questions with code B6 have good quality in measuring misconceptions because they are in the top position, while questions with code B10 are questions that have little potential to answer misconceptions by participants. In addition to the potential to answer the lowest misconceptions. Likewise, during the pre-test, question B6 still had good quality in measuring misconceptions and was added to question B2. In addition, items that have the potential to be answered with a few misconceptions by students are the same as the pre-test, namely, with question code B10. Furthermore, a comparison of students' misconceptions for the control class can be presented in Figure 9.



(a) Pre-test (b) Post-test

Figure 9 Comparison of potential misconceptions of control class students

Based on students' misconception scores, students with codes 12P, 21P, and 30P have the highest misconception scores because they are at the top. Meanwhile, students with code 06P have the lowest misconception score because they are at the bottom of the ranking. This shows that all students have the potential to answer all questions with misconceptions. Questions with code B7 have good quality at measuring misconceptions because they are in the top position, whereas questions with code B1 have little potential to answer misconceptions by students. Next, there is a change for the results post-test: students with code 26P have the potential to answer the highest number of misconceptions, and students with codes 28P, 29P, and 31P have the potential to answer the lowest number of misconceptions. At the moment, pre-test question B7 is still of good quality in measuring misconceptions. Apart from that, items that have the potential to be answered with a few misconceptions by students are the same as the pre-test, namely with question code B1.

In this research, the fluid dynamics material discussed consists of two main sub-concepts: the principle of continuity and the Bernoulli principle. From the results of calculating the average misconceptions and decreasing quantity of misconceptions (DQM) of students in the experimental class and control class which are shown in Table 3, the average misconception values and DQM values and their interpretations were obtained for each sub-concept in the fluid dynamic material which is presented in Table 4.

Table 4 Average misconceptions of students and DQM scores on the dynamic fluid sub-concept

Class	Dynamic Fluid Sub Concept	Pre-test	Post-test	DQM	Interpretation
Experimental	Continuity Principle	0.49	0.05	0.95	High
	Bernoulli's Principle	0.35	0.12	0.62	Moderate
Control	Continuity Principle	0.25	0.16	0.92	High
	Bernoulli's Principle	0.41	0.27	0.38	Moderate

Table 4 shows the results of calculating the average student misconceptions and DQM scores on the Principles of Continuity sub-concept. It was found that the highest DQM score was in the experimental class, namely 0.95 with the interpretation "High," while in the control class, it was 0.92 with the interpretation "High." In this sub-concept, both classes experienced a decrease in misconceptions, where the decrease in misconceptions in the experimental class was greater than in the control class, with the difference in DQM values between the two is 0.03. Meanwhile, for the Bernoulli Principle sub-concept, the DQM value in the experimental class was 0.62 with a "Medium" interpretation, and for the control class, it was 0.38 with a "Medium" interpretation. In sub-concepts, both classes experienced a decrease in misconceptions where the decrease in misconceptions in the experimental class was more significant than in the control class, with the difference in DQM value between the two being 0.24.

Three stay two stray learning assisted by ARaRaT has a high impact on reducing students' misconceptions. This shows that learning has an impact on reducing students' misconceptions. Therefore, cooperative learning type three stays on two tracks and can be used as an alternative to reduce students' misconceptions. Students can exchange information related to dynamic fluid phenomena in the student worksheets during the learning process. Information is exchanged with fellow friends in the group and two guests in the group so that students understand dynamic fluid concepts more deeply. This is the positive side of reducing

misconceptions and increasing students' concept understanding using three stay two stray learning assisted by ARaRaT.

This is in line with previous research conducted by Rahmi (2018) that there was a reduction in students' misconceptions after applying the Three stay two stray cooperative learning model. The research results on using AR in experiments show that these applications can help students understand concepts directly and observably and strengthen their experimental skills through practical experience (Cai et al., 2013). Learning media with AR technology is to be successfully applied, as seen from the increase from the average pre-test to post-test. If the post-test value of student learning outcomes is higher than the pre-test value, it can be said that student learning outcomes have increased (Marneanu et al., 2014). Learning media with AR technology is easier to use than conventional learning media (Pebrianti., 2014). Students also feel more comfortable and accustomed to using AR technology, which improves the laboratory's quality. Augmented reality helps in various aspects, such as providing videos, animations, and images, and helps students develop a positive attitude while working in the laboratory (Akçayir et al., 2016).

CONCLUSION

Based on the results of research and data analysis, it was concluded that there were differences in students' understanding of concepts regarding dynamic fluid material between students who were given treatment using TSTS learning assisted by ARaRaT and students who were only given treatment using TSTS learning. Misconceptions of students who take part in TSTS learning assisted by ARaRaT showed relatively better results than students who only took part in learning TSTS.

In further research, it is hoped that the implementation of learning will be implemented TSTS with the help of ARaRaT it can also be used to reduce students' misconceptions about other physics material.

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