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THE EFFECT OF PROBLEM BASED LEARNING WITH TEAM ASSISTED INDIVIDUALIZATION, PROBLEM BASED LEARNING WITH THINK PAIR SHARE, AND COGNITIVE MODELS ON LEARNING OUTCOMES

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Abstract : *This study was to determine the effect of a combination of problem-based learning with team-assisted individualization, problem-based learning with think pair share, and cognitive style on learning outcomes. This type of research is a quasi-experimental design that uses a 2x2 factorial design. The research population was XI Mathematics and Natural Science (MIPA) students in SMAN 1 Kraksaan and XI Mathematics and Natural Science (MIPA) of SMAN 1 Paiton Probolinggo, East Java, Indonesia, in 2022/2023. the samples were selected non-randomly, consisting of problem-based learning with team-assisted individualization (control) and PBL-TPS (experimental) groups. In both groups, given cognitive style test. The research instrument was 25 multiple-choice questions. Instrument validation is valid (0.89) and reliable (0.94). Posttest results were analyzed by two-way ANOVA test through SPSS v. 25. The study's results were; 1) There are differences in learning outcomes between problem-based learning with team-assisted individualization groups and problem-based learning with think pair share; 2) There are differences in learning outcomes between groups of cognitive style Field Dependent with cognitive style Field Independent; and 3) There is no interaction between learning models and cognitive styles on learning outcomes.*

Keywords : *Problem Based Learning; Cognitive Model; Learning Outcomes.*

Abstrak : *Penelitian ini bertujuan untuk menentukan pengaruh kombinasi pembelajaran berbasis masalah tipe team-assisted individualization, pembelajaran berbasis masalah tipe think pair share, dan gaya kognitif terhadap hasil belajar. Penelitian ini menggunakan jenis desain kuasi-eksperimental yang menggunakan desain faktorial 2x2. Populasi penelitian ini adalah siswa kelas XI Matematika dan Ilmu Alam (MIPA) di SMAN 1 Kraksaan dan SMAN 1 Paiton Probolinggo, Jawa Timur, Indonesia, pada tahun 2022/2023. Sampel dipilih secara non-acak dan terdiri dari kelompok pembelajaran berbasis masalah tipe team-assisted individualization (kontrol) dan kelompok pembelajaran berbasis masalah tipe think pair share (eksperimental). Pada kedua kelompok, dilakukan tes gaya kognitif. Instrumen penelitian terdiri dari 25 soal pilihan ganda. Validasi instrumen menunjukkan validitas (0,89) dan reliabilitas (0,94). Hasil postest dianalisis dengan uji ANOVA dua arah melalui SPSS versi 25. Temuan penelitian ini adalah; 1) Terdapat perbedaan dalam hasil belajar antara kelompok pembelajaran berbasis masalah dengan individualisasi yang dibantu tim dan kelompok pembelajaran berbasis masalah dengan berpasangan berpikir; 2) Terdapat perbedaan dalam hasil belajar antara kelompok gaya kognitif Tergantung Lapangan dengan gaya kognitif Tidak Tergantung Lapangan; dan 3) Tidak ada interaksi antara model pembelajaran dan gaya kognitif terhadap hasil belajar.*

Kata Kunci : *Pembelajaran Berbasis Masalah; Model Kognitif; Hasil Belajar.*

INTRODUCTION

In fostering students' skills and reasoning power, teachers as facilitators can create a good learning process, vary, and consider the characteristics of teaching materials and the characteristics of students (Fadlillah, 2023). Varied learning can create the desired quality of learning. Good learning quality can be achieved if a teacher can manage, design, and process learning by referring to everything that can be a benchmark for a teacher in achieving learning success (Dimyati & Mudjiono, 2015). The determinants of this learning process are goal characteristics, subject matter characteristics, student characteristics, teacher characteristics, and environmental characteristics (Samroni et al., 2021).

Chemistry is a material synonymous with counting, contextual, and abstract. Kean and Middlecamp state that most chemistry is abstract, a simplification of the real thing, and chemistry is sequential and develops faster. Chemistry is more than just solving problems and materials studied in chemistry. Students experience difficulties learning chemistry because they need help understanding how to learn chemistry, connect concepts, and cannot use logic, language, and mathematics (Zakiyah et al., 2018). The types of learning difficulties experienced by students in understanding chemistry include students' understanding of chemical material and their ability in mathematics (Priliyanti et al., 2021).

Therefore, a cooperative learning model is applied to overcome these problems to help make it easier for students to understand chemical material, especially acid-base solutions, and improve their learning outcomes. Nugroho stated that cooperative learning is an effort to help students understand the material in the learning process (Santoso et al., 2016; Abdullah & Omar, 2022; Diana & Sholehah, 2022). The cooperative learning model has been around for a long time, but applying two combinations or a combination of learning models has yet to be widely implemented in research. Based on the abstract nature of acid-based solution material related to chemical reactions and calculations, applying a combination of two learning models in managing learning is necessary.

The learning model combines problem-based learning with an assisted individualization model and problem-based learning with a think-pair-share model. Therefore, a problem was formulated in this study, among others; 1) Is there a difference in learning outcomes between students who get problem-based learning with team-assisted individualization model combination teaching and students who get PBL-TPS model combination teaching?; 2) Is there a difference in learning outcomes between students who have a cognitive style field independent (FI) and students who have a cognitive style field dependent (FD)?; 3) Does the combination of problem-based learning with an assisted individualization model, problem-based learning with think pair share and cognitive style influence learning outcomes?. So, the purpose of the study is to determine the difference in learning outcomes of students who get a combination of teaching problem-based learning with team-assisted individualization, problem-based learning with think pair share and

cognitive style, and the interaction effect of two combinations of learning models with cognitive style on learning outcomes.

Arends stated that Problem-Based Learning is learning that trains students to solve real, authentic problems to build their knowledge develop inquiry, and HOTS thinking skills (Amhar, 2021). The think-pair-share learning model is an effective cooperative learning model to vary the atmosphere of discussion patterns (Kurniawan et al., 2018). Think pair share type cooperative learning prioritizes thinking in pairs, making it easier for students to interact with their friends, respect differences with their friends, and be responsible for learning (Gunawan Maryoto, 2016). Slavin explained that team-assisted individualization is one of the attractive cooperative learning models because it applies a combination of two things, namely learning with each individual's ability and group learning (Ngilamele et al., 2019). The team-assisted individualization learning model can minimize ineffective individual learning, improve knowledge and abilities, and motivate students with group learning (Kusuma et al., 2018). Both team-assisted individualization and think pair-share models will enable students to work together, need each other, and depend on each other in small groups cooperatively (Noor, 2019).

In Learning to Teach, Arends states, "Teachers apply two main strategies to meet the needs of all students-using multiple models of instruction. Using multiple models means teachers take several teaching models and choose different approaches depending on the learning objectives. It also means that they can connect and use different models in tandem during a lesson or a unit of work" (Hardiyan, 2014). In this case, multiple models can be interpreted as applying varied learning models known as combined learning models. A combined learning model will give different characteristics to a single learning model.

The problem-based learning and team-assisted individualization combination learning model will provide new characteristics that still show the characteristics of each model. The stages of problem-based learning with team-assisted individualization combination learning model include; 1) Placement test and group formation; 2) Learner orientation to the problem; 3) Individual learning; 4) Learning in groups; 5) Giving posttest; 6) Analyzing problem-solving and evaluating the process; and 7) Rewarding the group. These stages bring together the stages of problem-based learning and team-assisted individualization. The stages of the think pair share combination learning model are; 1) Orientation of learners to the problem; 2) Thinking individually; 3) Pairs form groups; 4) Sharing; 5) Analyzing and evaluating the problem-solving process; and 6) Rewarding. In essence, this combination of learning models begins with giving problems, which are then solved with the team-assisted individualization and think pair share models (Krzic, Brown, & Bomke, 2020).

Learning success is also determined by the characteristics of students' cognitive styles (Güner & Gökçe, 2021; Umiarso, Baharun, Zamroni, Rozi, & Hidayati, 2021).

Cognitive style is self-potential in the way learners process information and think in solving problems (Sayogo et al., 2020). Through this test, students can know their thinking style, classified as a field-independent (FI) or field-dependent (FD) thinking style. Witkin states that students with a field-dependent thinking style tend to think globally; it is difficult to focus on a situation or analyze a pattern into various kinds (Nurmutia, 2019). Meanwhile, students with field-independent cognitive styles easily accept separate components of something whole and can analyze these components (Noviyanti et al., 2021).

Teachers need to apply a combination of learning models in learning widely. However, the application of a combination of problem-based learning with team-assisted individualization and problem-based learning with think pair share models has been applied by several teachers, such as the application of a combination of PBL and team-assisted individualization learning models can increase the maximum percentage of completeness (Salim & Hidayati, 2021). The application of the Problem Learning (PBL) based Team Assisted Individualization learning model can improve the learning outcomes of 8th-grade students at An-Nisa Junior High School, with the percentage of classical completeness from the pre-cycle of 45.83% increasing to 55.56% in cycle I and increasing in cycle II to 92.59% (Wahyudi et al., 2021).

The research results from Harisi et al., (2020) concluded that classical learning completeness could be achieved by applying a combination of problem-based learning and team-assisted individualization learning models. Amelia (2019) stated that using the problem-based learning model combined with the team-assisted individualization model influenced the understanding of mathematical concepts of grade IV students on the material of Equivalent Fractions and Fractional Forms at MIN 11 Bandar Lampung. Learning using the problem-based learning approach with the think pair share type cooperative learning model improves problem-solving skills and self-confidence (Sugiarti & Dewanti, 2018). The learning outcomes of students who apply the problem-based learning think pair share and direct instruction models at SMP Negeri 10 Manado (Lestari et al., 2020) are the same. There was an increase in the percentage of automotive electrical learning outcomes in cycle II due to the application of the combined problem-based learning and think pair-share learning model (Hardiyan, 2014).

METHOD

This research is a type of quasi-experimental research design that uses a 2x2 factorial design. The use of a 2x2 factorial design in this study is because researchers want to know the impact of the causal variable (independent), the moderator variable on the effect variable (dependent), and the interaction/relationship effect of two causal variables and one moderator variable on the dependent variable. This design is a development of true experimental design, which allows moderator variables to influence the treatment

(independent variable) and the outcome variable (dependent variable). The structure chart and 2x2 factorial design can be seen in Table 1.

Table 1: Structure of Factorial Design

Cognitive Style	Learning Model	
	Combination (A_1)	**Combination (A_2)**
***Field Dependent* (B_1)**	($Y_{1\,1n}$) A_1B_1	($Y_{1\,1n}$) $A_2\,B_1$
***Field Independent* (B_2)**	($Y_{2\,1n}$) A_1B_2	($Y_{2\,1n}$) $A_2\,B_2$

Source: Emzir (2015) and Trochim (2006)

Based on table 1, A1 as a group of students whose learning uses a combination learning model problem based learning with team assisted individualization; A2 as a group of students whose learning uses a combination learning model problem based learning with think pair share; B1 as a group of students with cognitive style field dependent (FD); B2 as a group of students with cognitive style field independent (FI); A1 B1 as a group of students whose learning uses a combination learning model problem based learning with team assisted individualization with cognitive style field dependent (FD); A1 B2 as a group of students whose learning uses and has a combination learning model problem based learning with team assisted individualization with cognitive style field independent (FI); A2 B2 as a group of students whose learning uses a combination learning model problem based learning with think pair share with cognitive style field independent (FI); A2 B1 as a group of students whose learning uses a combination learning model of problem based learning with think pair share with cognitive style field dependent (FD); Y is the learning outcomes Acid-Base; and n is the nth subject.

This research was conducted from January 9 to February 21, the odd 2022/2023 academic year semester. The population in this study were students of class XI Mathematics and Natural Sciences (MIPA) SMAN 1 Kraksaan and XI MIPA SMAN 1 Paiton Probolinggi, East Java Indonesia, in the 2022/2023 academic year. The sample in this study was selected non-randomly, consisting of one class as a control group applying a combination of problem-based learning with team-assisted individualization models and one class as an experimental group applying a combination of problem-based learning with think-pair share models. In this study, a moderator variable is cognitive style.

Each group was first given a cognitive style test and pre-test in this study. Then, the process of teaching and learning activities that apply a combination of problem-based learning with team-assisted individualization, problem-based learning with think pair share models, and a post-test after all the material is given to students. The instrument for the cognitive style test is as many as 25 items of pictorial questions Group Embedded Figures Test (GEFT). Seven items in the form of simple images are carried out in the first session for 10 minutes and are considered practice or introduction to the image pattern. In the second

session, nine pictorial items were more complicated than the first session pictures and were administered in 15 minutes. In the third session, the nine picture items were even more complicated than in the first and second sessions. The third session also lasted 15 minutes. The results of this cognitive test will be classified into two groups: cognitive style, cognitive style field independent (FD), and cognitive style field dependent (FD).

Learning outcomes instrument in the form of 25 multiple choice questions acid-base solution. This instrument was validated first before being used for pre-test and post-test. Instrument validation resulted in a validity value of 0.89 and reliability of 0.94 with a very valid and reliable category. The research data is the post-test results of students, which the two-way ANOVA test will analyze through the SPSS version 25 program. On the post-test results data, normality and homogeneity tests were carried out before the two-way ANOVA test. The two-way ANOVA test was conducted to determine the effect of the combination of problem-based learning with team-assisted individualization, problem-based learning with think pair share and cognitive style models, and the interaction effect of the combination of problem-based learning with team-assisted individualization, problem-based learning with think pair share and cognitive style models on learning outcomes.

RESULT AND DISCUSSION

Data from this study include data on the results of instrument validation (question quality test), data on the results of cognitive style tests, data on pretest-posttest results, and data on the results of hypothesis testing. The number of sample members in each school can be seen in Table 2.

Table 2: Data on Number of Sample Members

Class	Treatment	Number of Students	Percentage
XI MIPA-1 Kraksaan	PBL with team assisted individualization	32	25 %
XI MIPA-2 Kraksaan	PBL with think pair share	32	25 %
XI MIPA-1 Paiton	PBL with team assisted individualization	33	25 %
XI MIPA-2 Paiton	PBL with think pair share	33	25 %
Total		130	100

Based on table 2, the number of sample members is the same in one school, and the number of sample members differs for different schools. The total number of sample members in this study was 130 students. At the time of the implementation of learning that applies the learning model in research in class XI Mathematics and Natural Sciences (MIPA), a test of the quality of the questions is carried out, which includes validation, reliability, difficulty level, and differentiating power on the question instrument. The instrument

questions are in the form of multiple-choice acid-base questions of as many as 25 items. The research subjects for this validation test were 30 students of class XII Mathematics and Natural Sciences (MIPA) SMAN Paiton Probolinggo East Java Indonesia. The results of the instrument validation can be seen in Table 3.

Table 3: Results of Instrument Item Analysis

Question Quality	Value	Category
Validity	0,89	Very High
Reliability	0,94	Very High
Level of Difficulty	92 % moderate	Problem Moderate
Distinguishing Power	6,82	Acceptable

Based on Table 3, the research instrument includes a very valid and highly reliable category. The difficulty level of the question is moderate, so this research instrument is suitable for use as a pretest and posttest. The following research sample was given a cognitive style test or thinking style. The results of the cognitive style test can be seen in Table 4.

Table 4: Results of Cognitive Style Test in Learning Model Group

Cognitive Style	Learning Model		Total
	PBL with team assisted individualization	PBL with think pair share	
Field Independent (FI)	38	37	75
Field Dependent (FD)	27	28	55
Total	65	65	130

Table 4 shows that of the 130 students as a sample of research obtained, 75 students with cognitive style Field independent and 55 students field dependent. In the next stage, after the research sample gets the cognitive test, students do a pretest test and finish learning, then do a post-test. Post-test results are research data that will be tested for normality and homogeneity as a condition for conducting a two-way ANOVA test. The results of the pretest and post-test can be seen in Table 5.

Table 5: Pre-test and Post-test Results

Group	*Pre-test*			*Post-test*		
	Min.	Max.	Average	Min.	Max	Average
Control (PBL with team assisted individualization)	16	72	46,34	56	92	73,23
Experiment (PBL with think pair-share)	12	80	45,11	56	96	76,80

Based on the pretest and posttest data in Table 5, initially, the experimental group, before being given the treatment of applying the combination learning model, had a lower pretest average value than the control class. However, after being given treatment in each sample class with a different combination learning model, the average value of posttest learning outcomes of the experimental class (problem-based learning with think pair share combination) is greater than the control class (problem-based learning with team-assisted individualization combination).

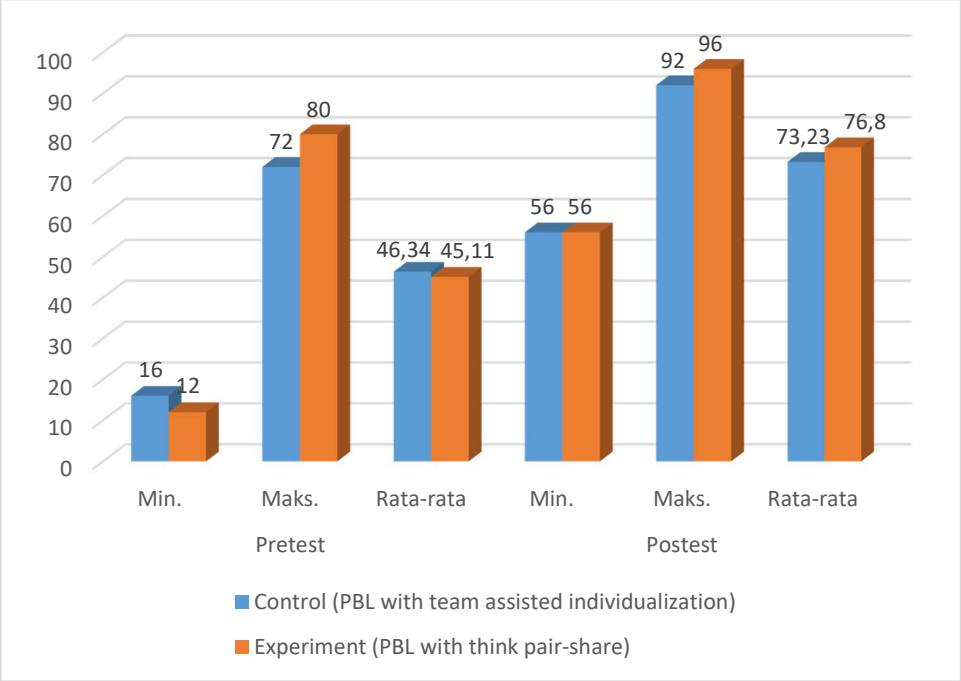

Figure 1: Histogram of Comparison of Pre-test and Post-test Results in Different Groups

The results of post-test data analysis using the SPSS version 25 program can be seen in Table 6.

Table 6: Results of Descriptive Analysis of Post-test Data

Learning Model	Cognitive Style	Mean	Standard Deviation	Number Sample
PBL_TAI	*Field Independent* (FI)	75.58	8.763	38
	Field Dependent (FD)	69.93	8.105	27
	Total	73.23	8.886	65
PBL_TPS	*Field Independent* (FI)	77.51	8.608	37
	Field Dependent (FD)	75.86	9.268	28
	Total	76.80	8.866	65
Total	*Field Independent* (FI)	76.53	8.683	75
	Field Dependent (FD)	72.95	9.140	55
	Total	75.02	9.021	130

The results of descriptive analysis of posttest data (acid-base learning outcomes) in Table 6 explain that in the problem-based learning with team-assisted individualization combination learning model, the average value of the posttest of students with cognitive field independent (FI) style is 75.58 greater than the average value of the posttest of students

with cognitive field dependent (FD) style of 69.93. The average posttest value of students with a cognitive field independent (FI) cognitive style of 77.51 in problem-based learning with a think-pair-share combination learning model is greater than that of students with a cognitive field dependent (FD) cognitive style of 75.86.

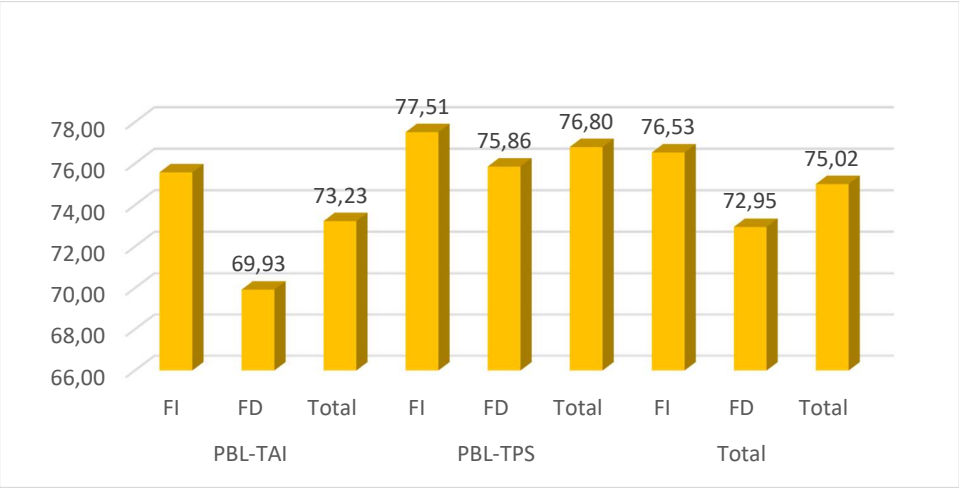

Figure 2: Histogram of Comparison of Post-test Mean Values Based on Cognitive Style and Learning Model

Research hypothesis testing includes testing to determine the effect of independent variables and moderator variables and to determine the interaction effect of independent variables and moderators on the dependent variable. Before hypothesis testing, prerequisite tests must be carried out which include normality test and data homogeneity test. Testing the normality of the data in this study using the Kolmogorov-Smirnov normality test. This data normality test includes data normality testing based on the learning model. The results of normality testing can be seen in table 7.

Table 7: One Sample Kolmogorov-Smirnov Test

		PBL with team assisted individualization	PBL with think pair share
N		65	65
Normal Parameters[a.b]	Mean	72,23	76,80
	Std. Deviation	8,886	8,866
Most Extreme Differences	Absolute	,107	,098
	Positive	,107	,098
	Negative	,085	,087
Test Statistic		,107	,098
Asymp. Sig. (2-tailed)		.064	,200

a. Tes distribution is normal
b. Calculated from data

Table 7, as above, shows the significance value of 0.064 in the problem-based learning with team-assisted individualization combination group is greater than the significance level value ($^{\alpha}$ = 0.05), and the significance value of 0.200 in the problem-based learning with think pair share combination group is also more significant than the significance level value ($^{\alpha}$ = 0.05). The data concluded that both control and experimental classes had a normal data distribution in both sample groups. This means that the research data (posttest) has met the first requirement to go to the data hypothesis test. Data homogeneity test results based on the learning model and cognitive style can be seen in Table 8.

Table 8: Homogeneity Test Results Based on Learning Model and Cognitive Style

	Levene Statistic	df1	df2	Sig.
Acid-Base Learning Results	,198	3	,126	,898

The post-test data tested for normality and homogeneity is then tested using two-way ANOVA to test the hypothesis of this study. The results of the two-way ANOVA test can be seen in Table 9.

Table 9: The Results of the Two-way ANOVA

Source	Type III Sum Of Squared	df	Mean Square	F	Sig.
Corrected Model	962.182[a]	3	320.727	4.238	.007
Intercept	708411.848	1	708411.848	9360.517	.000
Learning Model	490.669	1	490.669	6.483	.012
Cognitive Style	423.709	1	423.709	5.599	.019
Learning Model * Cognitive Style	126.677	1	126.677	1.674	.198
Error	9535.787	126	75.681		
Total	742048.000	130			
Corrected Total	10497.969	129			

a. R squared = 092 (Adjusted R squared =.070)

Table 9 shows the R squared value of 0.092, which means 9.2% of the strength of the relationship between the independent and dependent variables. The test results also showed an F value of 6.483 and a significant value of 0.012 for the effect of the learning model factor on learning outcomes. F value of 5.599 and a significance value of 0.019 for the influence of cognitive style factors on learning outcomes. F value of 1.674 and a significance value of 0.198 for the effect of the interaction factor of learning model and cognitive style on learning outcomes.

Therefore, the effect of the problem based learning with team assisted individualization, problem based learning with think pair share, and cognitive models on learning outcomes as discussed below;

1. **The Difference in Acid-Base Learning Outcomes between the Problem Based Learning with Team-Assisted Individualization Combination Learning Model Group and the Problem-Based Learning With Think Pair-Share Combination Learning Model Group**

Based on the data in table 8, then for the first hypothesis test obtained the value of FA = 6.483. This value will be compared with the F table value for the significance level α = 0.05, namely F (0.05;1;128) = 3.92 and the significance value (sig) = 0.012. So the value of FA = 6.483 is greater than the value of Ftable = (3.92) with significance = 0.012 less than 0.05 so that H0A is rejected and H1A is accepted. This significance value of 0.012 is the conclusion of the fact that there is a difference between the mean value of the pretest and the mean value of the posttest in the experimental and control groups. In the experimental group, the mean value of the pretest was 45.11 and the posttest was 76.80. While in the control group the average value of the pretest was 46.34 and the posttest was 73.23. Overall, the average value of student learning outcomes in the experimental class (problem based learning with think pair share combination) is 76.685 greater than the average value of student learning outcomes in the control class (problem based learning with team assisted individualization combination).

At the time of the pretest the control class had an average value greater than the experimental class but for the posttest average value the experimental class was greater than the control class. The reference for learning success uses the last learning outcome or posttest after students get the material as a whole and treatment in the form of applying a combination learning model. This is evident for the experimental class or group of students who use the problem based learning with think pair share combination learning model is superior to the control class or group of students who use the problem based learning with team assisted individualization combination learning model. The superiority of learning outcomes of the experimental group (problem based learning with think pair share combination) can be seen in Figure 3.

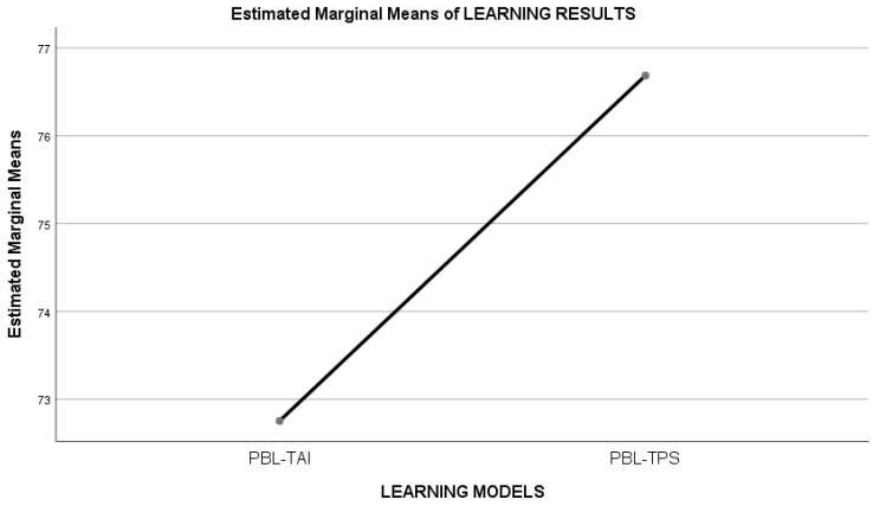

Figure 3: Plot Graph of the Effect of Learning Model on Learning Outcomes

In the analysis of the first hypothesis, the learning outcomes of students show optimal in the group of students who get learning with a combination of problem based learning with think pair share models than the group of students who get learning with a combination of problem based learning with team assisted individualization models. This means that through the application of the problem based learning with think pair share model combination, students more easily understand the acid-base solution material both for concepts and calculations. Classical sharing activities in the problem based learning with think pair share group are more effective. While in the problem based learning with team assisted individualization study group the learning outcomes were lower due to less optimal group work through peer tutors. This can happen if the tutor or friend who is considered to have more ability in the group is unable to make his friends understand and understand the concepts and calculations. This inability is due to too little or limited time that cannot understand his friends whose abilities vary. So, in problem based learning with team assisted individualization groups the number of group members must also be considered to adjust to the time allocation during learning. It is better to have a group of three children. One tutor helps two children. It is more optimal than one tutor holding or teaching three children so that it does not become a burden. In problem based learning with think pair share learning groups in one group there are only two children or one pair so that group work is more optimal and reinforced by explanations from classical sahring / sharing sessions through presentations.

The results of this study are in line with previous studies, among others: Amelia (2019) stated that the use of the PBL learning model combined with the TPS model had an influence on the understanding of the mathematical concepts of grade IV students on the material of Equivalent Fractions and Fractional Forms at MIN 11 Bandar Lampung. Learning using the PBL approach with the TPS type coopertaif learning model has the best effect on improving problem solving skills and self confidence (Sugiarti & Dewanti, 2018). There was an increase in the percentage of automotive electrical learning outcomes in cycle II as a result of the application of the combined PBL and TPS learning model (Hardiyan, 2014). There is an effect of the application of the Think Pair Share learning model on student learning outcomes for class IV SDN 77 Kota Tengah Kota Gorontalo (Rivai & Mohamad, 2021). Based on the results of research conducted by Wirevenska et al (2022), it was concluded that there was a comparison of the TPS and PBl learning models on students' mathematical communication for the material on the system of linear equations of three variables, each of which obtained an average value of 81.78 and 81.10.

2. The Difference in Acid-base Learning Outcomes Between Groups of Students Who Have a Field Dependent Cognitive Style and a Field Independent Cognitive Style

The results of the second hypothesis test obtained FB value = 5.599. This value will be compared with the Ftable value for the significance level $\alpha = 0.05$ ($\alpha = 5\%$), namely F (0.05; 1; 128) = 3.92 and the significance value (sig) = 0.019. So FB = 5.599 is greater than

Ftable = (3.92) with significance = 0.012 smaller than 0.05 so that H0B is rejected and H1B is accepted. The existence of this difference is based on the average value of learning outcomes of students with cognitive field independent (FI) style of 75.58 and the average value of learning outcomes of students with cognitive field dependent (FD) style of 69.93 in the control class (problem based learning with team assisted individualization combination). In the experimental class (PBL_TPS combination) students who are cognitive field independent (FI) have an average value of learning outcomes of 77.51 and students who are cognitive field dependent (FD) have an average value of learning outcomes of 75.86.

Overall, the differences in learning outcomes of students based on cognitive style resulted in an average value of learning outcomes of students who have cognitive style field independent (FI) of 76.53 and the average value of learning outcomes of students who have cognitive style field dependent (FD) of 72.95. These results can be seen in Figure 4.

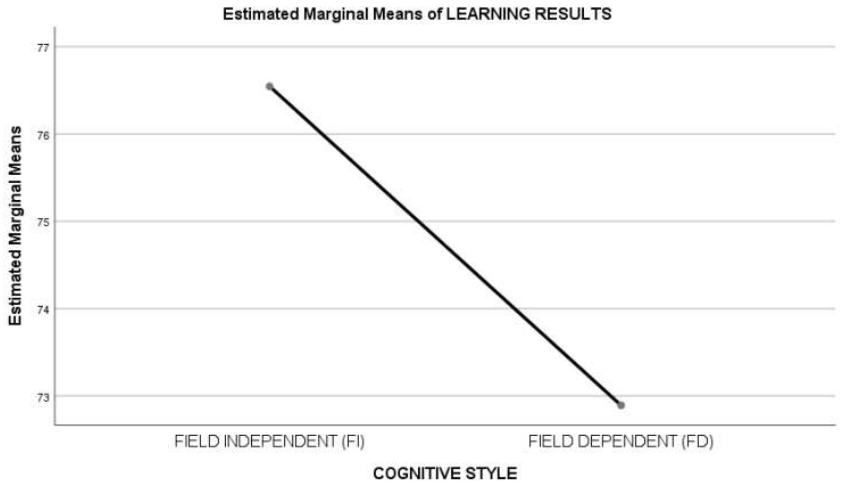

Figure 4: Plot Graph of the Effect of Cognitive Style on Learning Outcomes

On the results of the analysis of the second hypothesis shows the group of students who have cognitive style field indepedndent obtain higher learning outcomes than the group of students who have cognitive style field dependent. We know in this study obtained the number of students who have a cognitive style field independent higher than the group of students field depedndent both in problem based learning with think pair share study group and problem based learning with team assisted individualization study group. This is directly proportional to the expertise or specialization of students in the field of Mathematics and Natural Sciences which emphasizes and accustoms students to have the ability to analyze and independent, independent in learning. This potential also influences the acquisition of learning outcomes. As a result in the group of learners who have a cognitive style field

independent remain superior in the learning group with the application of different learning models.

Based on these data it can be concluded that there is a significant difference in the learning outcomes of students who have a cognitive style field independent (FI) with students who have a cognitive style field dependent (FD). The results of this study are in line with the results of research which states that the group of students with field independent cognitive style has better mathematical reasoning ability than the group of students with field dependent style (Mirlanda & Pujiastuti, 2018). Learners with a field independent thinking style are able to use spatial reasoning and represent well than field dependent participants who have not been able to apply spatial reasoning as well as not being able to represent appropriately (Utomo & Pujiastuti, 2020).

3. The Interaction of Student Learning Outcomes With Learning Models and Cognitive Styles

Based on table 8. the results of the third hypothesis test obtained the value FA = 1.674. This value will be compared with the Ftable value for the significance level α = 0.05 ($^{\alpha}$ = 5%), namely F (0.05;2;127) = 3.07 and the significance value (sig) = 0.19. So FA = 1.674 is greater than Ftable = (3.07) with a significance of 0.198 greater than 0.05 so that H0C is accepted and H1C is rejected. This means that the two variables studied do not produce a significant combination effect. Based on these data it can be concluded that there is no interaction of student learning outcomes with a combination of problem based learning with team assisted individualization learning model, problem based learning with think pair share combination and cognitive style field independent (FI) and cognitive style field dependent (FD).

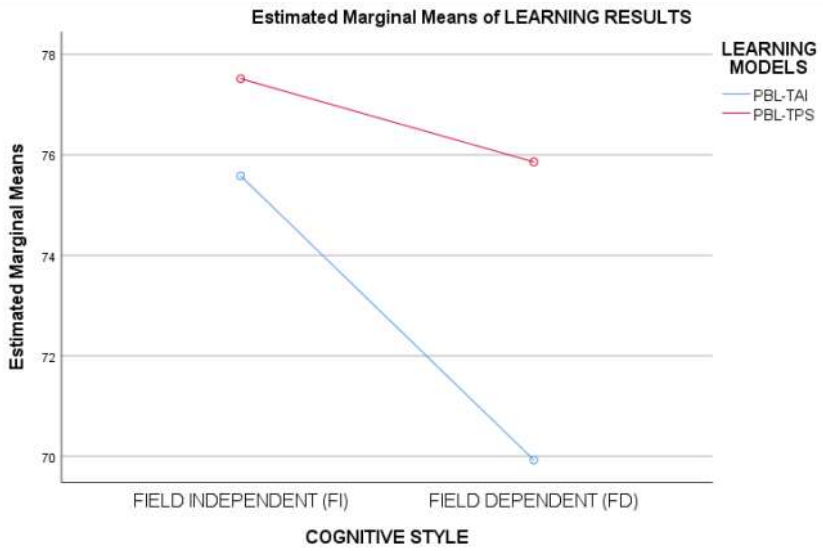

Figure 5: Graph of the Interactive Effect of Learning Model and Cognitive Style on Acid-Base Learning Outcomes

From the plot graph in Figure 5. displays two lines that are separate or not intersecting which indicates that there is no interaction on two variables, namely the learning model variable and the cognitive style variable in influencing student learning outcomes. The red line or problem based learning with think pair share combination learning model occupies a position above the blue line or problem based learning with team assisted individualization combination learning model. It shows that the use of problem based learning with think pair share combination learning model is more effective than problem based learning with team assisted individualization combination learning model. In the plot graph also shows students who have a cognitive style field independent (FI) with the treatment of problem based learning with think pair share combination learning model obtained higher learning outcomes than students who have a cognitive style field dependent (FD). Learners who have a cognitive style field independent (FI) and get a combined learning model treatment problem based learning with team assisted individualization also obtained learning outcomes superior to students who have a cognitive style field dependent (FD). Thus students who have a cognitive style field independent (FI) obtained superior learning outcomes in both the control class (problem based learning with team assisted individualization combination) and the experimental class (problem based learning with think pair share combination) than students who have a cognitive style field dependent (FD). Based on the results of the above analysis shows in this research sample students obtained posttest learning outcomes are not influenced by the absence of interaction between the application of a combination learning model with cognitive style.

CONCLUSION

Based on the results of data analysis and discussion, three conclusions can be drawn; 1) There is a significant difference in the learning outcomes of acid-base solutions between the group of students who received the problem based learning with team assisted individualization combination learning model and the group of students who received the problem based learning with Think Pair Share combination learning model. This indicates that the teaching method used significantly influences the students' learning outcomes in the context of acid-base solutions; 2) There is a difference in the learning outcomes of acid-base solutions between the group of students who have a Field Dependent cognitive style and the group of students who have a Field Independent cognitive style. This suggests that students' cognitive styles also play a crucial role in their learning outcomes in the topic of acid-base solutions; and, 3) There is no significant interaction between the application of the PBL with TAI learning model, the PBL with Think Pair Share learning model, and cognitive

style on the learning outcomes of acid-base solutions. This means that the influence of each of these factors on the learning outcomes of acid-base solutions does not significantly affect each other. In other words, students' cognitive style does not moderate the impact of the learning model on their learning outcomes in this topic.

These conclusions help us understand that in the context of learning about acid-base solutions, the choice of the learning model can have a significant impact on students' learning outcomes, and students' cognitive styles also have their own influence. However, there is no significant interaction between these two factors in this particular learning context.

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