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THE EFFECTIVENESS OF THE THINK-PAIR-PROJECT-SHARE (TP2S) MODEL IN FACILITATING SELF-DIRECTEDNESS OF PROSPECTIVE SCIENCE TEACHERS

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ABSTRACT

Self-directedness is a crucial skill for prospective science teachers, and the Think-Pair-Project-Share (TP2S) model has shown promise in fostering collaboration and critical thinking. This research aims to investigate the effectiveness of TP2S in promoting self-directed learning among these future educators. This quantitative research used a nonequivalent control group design. The population in this research consisted of second-semester students, while the research sample consisted of 72 students. The data collection technique used an instrument in the form of a scale. Based on the results of the paired sample T-test, it can be seen that both experimental classes obtained a Sig. (2-tailed) 0.000. It can be concluded that the paired sample T-test value in the experimental class is 0.000<0.05, so there is a significant difference in results between the pretest and posttest scores (H0 is rejected). There is a difference in self-directedness between students who study human and environmental subjects using the think pair project share model and those who use the conventional model. It is known that the application of the TP2S learning model has an effect on the self-directedness of prospective science teachers. The implications of this research support and strengthen the results of theoretical studies that the TP2S learning model is a student-centered learning model that utilizes the ability to manage learning strategies independently.

Keywords: learning model; self-directedness; science teacher; think pair project share

INTRODUCTION

Prospective science teachers need to train their self-directedness because it is a soft skill that helps them trigger their responsibility and independence in learning activities based on their initiatives. Prospective teachers must thoroughly learn and transfer science concepts to students (Parmin et al., 2019). Education development in the 21st-century era encourages prospective science teachers to be more responsible for the materials with their abilities and reduce dependence on learning resources from teaching staff due to the ease of access to information (Du Toit-Brits, 2019). Saija et al. (2022) explain that science education's primary goal is to make someone able to contribute to scientific literacy. In line with this opinion, the Program for International Student Assessment (PISA) in the UNESCO Science Report forum explains that the primary goal of scientific literacy is to create a young generation who is scientifically literate. An individual can contribute to scientific literacy by getting involved in the impact of science in everyday life to be able to solve real-life problems in the era of Revolution 4.0.

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The learning process is one of the curricular activities carried out by educational institutions to instill knowledge in students in order to achieve their academic goals; namely, good learning achievement cannot be separated (Nuraini et al., 2019). Adolescence, from the stage of psychosocial development, is a dynamic, sensitive, and vulnerable period. Adolescent children also have fewer opportunities to make decisions about themselves, and compared to adults, they may not have a sufficient set of strategies to overcome potential life difficulties (Pivarč, 2023). Educational institutions must be able to respond to these changes by adapting their teaching and learning processes and overall activities (Depoo & Smolová, 2022). The concept of learning and education should construct skills students need to prevail in the 21st century (Toto et al., 2021).

As adult learners, students are required to become independent learners. New students need to adapt to learning methods that differ from previous levels. One factor that can influence learning achievement is learning readiness. Self-directedness is one of the abilities that students must have as independent learners. Understanding the importance of self-directedness is one of the factors that can be used as a benchmark in measuring student learning success and achievement. Ru'iya (2019) states that students with high independent learning abilities will also produce high learning achievements. Fatmawati and Malik (2019) state that there is a close relationship between self-directedness and the achievements and learning outcomes obtained by students.

Self-directedness is the individual readiness to take initiative and responsibility for their learning. This is one of the essential things that students must master as adult learners. Students who can learn independently certainly have perseverance towards long-term goals. Self-directed learning is the strongest predictor of academic success in new students (Torun, 2020). Oducado (2021) believes self-directed learning readiness is valuable for student success. This research shows that students who are more independent, self-managed, self-controlled, and have an excellent desire to learn will have higher academic achievements.

Self-directedness is the process by which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning objectives, identifying human and material resources for learning, selecting and implementing appropriate learning strategies, and evaluating learning outcomes (Doğru & Özen, 2023). One of the changes in the learning paradigm is that the orientation of learning, which was originally teacher-centered, has shifted to student-centered (Tegeh et al., 2021). Lecturers as educators have an essential role in developing students' scientific literacy and self-directedness as prospective teachers. Because teachers play an essential role in realizing transformation in educational institutions (Reshmad'sa & Vijayakumari, 2017); this is in line with the opinion of Bhat and Dahal (2023), who state that self-directedness is carried out based on five important basic aspects, namely students' control of their learning experiences, skill development, good performance, student self-management, and motivation and self-assessment. Self-direction encompasses both the individual's internal process of learning and development as well as the external effects that come from instruction.

To make prospective teacher students competent and have 21st-century skills, lecturers must provide various learning strategies to equip them, including developing scientific literacy skills using appropriate learning models. The Industrial Revolution 4.0 concentrates primarily on learners and the learning process, where the organization of learning activities is experience-based and related to practical contexts to develop holistic competencies. The quality of teachers depends on achieving the graduate core competencies from the study program where they study (Parmin et al., 2017).

An initial survey using a questionnaire given to first-year prospective science teacher students obtained data that 39 students were reluctant to sacrifice their free time to complete assignments, 20 students did not complete assignments optimally, and 27 students were reluctant to complete difficult assignments that took a long time. This illustrates the variety of learning readiness possessed by students. Most students have long-term goals and are aware that there will certainly be various obstacles to achieving long-term goals. This shows that students still do not have the desire to overcome the obstacles they experience and choose to give up on their coursework.

These findings indicate variations in the level of learning readiness among students. Even though they have long-term goals, they have not shown strong determination to overcome obstacles in the learning process. This can hinder the achievement of their learning goals. Based on the survey results and a general understanding of the factors that influence learning readiness, several factors that may contribute to students' unreadiness for learning may be that they do not have adequate time management skills, so they have

difficulty completing assignments on time and with good quality. Students may not have adequate learning strategies to understand complex science subject matter. Implementing appropriate learning models can help increase students' learning readiness and motivate them to achieve their learning goals. In addition, it is essential to build a supportive learning environment and encourage students to learn independently.

However, experience-based learning and participation in experiential learning activities have not attracted much attention from scholars and researchers (Hien & Oanh, 2018). Lecturers can choose many ways and learning models to help students improve their self-directedness. A learning model is a plan used as a guide in planning and implementing learning in the classroom. The learning model refers to the learning approach, which includes teaching objectives, stages in learning activities, learning environment, and classroom management (Irvy, 2020). Therefore, a teacher must determine the appropriate learning model to create fun and meaningful classroom learning conditions (Aryantiningsih, 2021). Teacher learning activities are repetitive but dominated by lecture techniques. Teachers view learning activities using the lecture method as easier conveying material, although it generally makes students more passive and have difficulty thinking critically (Ridwan & Hadi, 2022).

Think Pair Share is a learning model that teachers can use. Cooperative learning refers to learning in which students are formed in small groups. Think-Pair-Share is one strategy that requires students to interact for a specific time with their partners to share ideas (Ningsih, 2019). Think, Pair, and Share (TPS) is a cooperative learning model that encourages students to participate in group discussions, think critically about the problems given, and be able to present them. Think-pair-share provides opportunities for students to reflect on the questions asked and then practice sharing and accepting potential solutions (Radhakrishnan et al., 2019). The procedure for implementing the TPS model is to give students more time to think about responding and helping each other with their friends (Iqbal & Riskasusanti, 2020). Think pair share has several benefits for students. The first is that through this technique, students learn how to accept opinions from others. The technique also gives students the learning opportunity to improve their higher-order thinking skills. Furthermore, students have confidence when they speak and stand in front of the class and share the results of discussions with their friends (Maulani et al., 2020). This aligns with previous research conducted by Ningsih et al. (2019) concerning the effect of the TPS learning model on critical thinking ability. The results of this research indicate that the think-pair-share method can improve students' thinking skills. As a result, students' thinking ability is better and is in line with the learning achievements of students. Another study conducted by Rozie (2022) examines the efficacy and practicality of the Think Pair Share cooperative learning model learning device, which is supplemented by multimedia learning, at SDN Tanamera 1 Bangkalan to increase student learning outcomes. The results of the student evaluation tests that have met the KKM overall demonstrate the effectiveness of the developed learning tools; the improvement in student learning outcomes is evident in the calculation of learning outcomes that are in the very good category for as many as six people, and two more are classified as good in order for the developed learning tools to be deemed effective.

Wuryandani and Herwin (2021) present the effect of the think–pair–share learning model on student learning outcomes in Civics in elementary school. Using this learning framework can enhance elementary school students' civics learning outcomes. A positive rise in students' learning outcomes following the application of this learning approach serves as proof.

However, no matter how well the method is implemented, it certainly has weaknesses in its application in the learning process, including the think-pair-share model. These shortcomings include having time limits that are out of proportion to the number of groups, the possibility of fewer ideas emerging, and the lack of a mediator in the event of a conflict between group members. TPS offers benefits, including being an excellent means of getting students actively involved in the learning process. This is particularly true during the pair stage where students collaborate to talk about what they have previously thought, concentrate on the answers, include one another, and concentrate on conversations with the teacher and other students (Gok, 2018). Therefore, one of the things that can be done to overcome the weaknesses is to modify the model by adding syntax to create projects in groups, also known as team-based projects.

The effectiveness of project-based learning depends on the lecturer's ability to condition learning effectively by motivating students and supporting and guiding them during learning. In this method, lecturers provide more opportunities for students to develop their abilities in working together to create project assignments related to

the material provided (Halimatusyadiyah, 2022). Project-based learning is an approach that ensures active student participation and develops higher-order thinking skills, supported by various tools and resources. It aims to incorporate everyday skills into the classroom environment and transfer the acquired knowledge and skills to everyday life at the end of the process. The importance of utilizing computers and other technology as tools is emphasized (Ozkan, 2023). PjBL not only provides students with knowledge but is also effective in developing problem-solving, communication, creative thinking, lifelong learning skills, teamwork, adaptation to change, and self-evaluation skills. PjBL is a learning approach that includes various methods and strategies and aims to help students acquire and use the information (Taskiran, 2021). Students can arrange their thoughts as part of an exchange process, share knowledge, and learn from others in a collaborative learning environment. As they cannot experience everything themselves, they must be able to acquire the knowledge, ideas, and actions of others by integrating, sharing, enriching themselves, and gaining recognition from others (Crespí et al., 2022; Rupavijetra et al., 2022).

Think pair share provides opportunities for students to think highly, respond, and interact. This aims to support students in improving their high-level thinking skills so they can understand teaching materials (Kurjum et al., 2020). The steps that must be taken in implementing the team-based project learning method are to orient the problem, identify the given case, design the prototype, implement the prototype, present the project, and finally do the evaluation (Aristin & Purnomo, 2022).

The think-pair-project-share (TP2S) learning model is oriented toward student-centered learning. The characteristics of each student are used as the basis for building the learning process, delivery of learning, and evaluation of learning. Project-based learning is a learning strategy that facilitates students in finding knowledge independently and demonstrating their new understanding through various presentations. It is a learning model that involves projects in the learning process (Sulistyorini & Purwanti, 2018). This evaluation covers the entire learning outcomes, including project objectives as intermediate goals and competency development as the final goal (Crespí et al., 2022).

Assessments conducted by teachers, students, and team members are perfect for this type of work, as they provide a comprehensive assessment of learning outcomes. Some benefits of student-centered learning are gaining new knowledge and skills, encouraging students to improve their ability to solve a problem, and developing and improving students' skills in managing resources to complete the assigned tasks.

Drawing from the description above, the purpose of this research is to investigate the effectiveness of the modified think-pair-project-share (TP2S) learning model in facilitating student self-directedness. The learning processes help individuals to become more self-directed, therefore it is believed that this research can give an overview of the effectiveness of the TP2S model. Furthermore, this research is crucial since it can assess the effectiveness of the modified learning model, allowing for the use of the developed learning model.

This research exploring self-directedness is critical because self-directedness is an essential ability for prospective teachers to learn independently and continue to develop throughout life. Self-directed teachers can adapt learning to students' needs and interests, follow the latest developments in education, develop creative and innovative learning materials, and build positive relationships with students. This research also has important implications for educational practice and policy development. The results of this research can help improve the quality of prospective teacher education and prepare them to teach effectively in today's digital era. This research only focuses on first-year science teacher candidates. Research results may not be directly generalizable to other groups, such as prospective teachers from other subjects or prospective teachers at different educational levels. The study had a limited sample size and only focused on prospective teachers at one public university in Central Java, which may limit the generalizability of the research results.

By examining the effectiveness of the TP2S model in developing the learning independence of prospective science teachers, this research is expected to provide the following benefits: (1) Improving the quality of science teachers: Prospective science teachers with high levels of self-directedness will be better able to implement student-centered learning and encourage students to learn independently; (2) Producing better-prepared science graduates: Prospective science teachers accustomed to independent learning will be better prepared to face challenges in learning science at school; (3) Contributing to the development of science learning: The results of this research can be a basis for developing science learning models that effectively increase student learning

independence. In short, this research is essential because it can improve the quality of science teachers and science learning in the future.

METHODS

The main design of this study is quasi-experimental. In this study, the researchers used a nonequivalent control group research design. The following is the nonequivalent control group design.

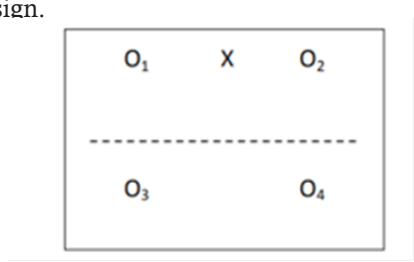

Figure 1. Nonequivalent Control Group Research Group

Description:
O1: Self-directedness at the beginning of the experimental class
O2: Self-directedness at the end of the experimental class
O3: Self-directedness at the beginning of the control class
O4: Self-directedness at the end of the control class
X: The given treatment, namely the think pair project share model (Sugiyono, 2017)

The population in this research was all prospective science teacher students in semester II, totaling 72 students. Sugiyono (2019) explains that a sample is part of the whole and the characteristics of a population. The samples taken in this research were two classes, with details of one class as the control class and one class as the experimental class. The instrument used in this research was a scale with aspects of self-directedness presented by Fisher et al. (2001). Table 1 shows the aspects and indicators used in this research.

Table 1. Aspects and Indicators of Self-Directedness (Fisher, 2001)

No	Aspects	Indicator	Item Number		Total
			Favorable	Unfavorable	
1	Self-management	-Adjustability -Discipline and time management -Problem-solving skill	2, 5, 10 6, 38, 42, 1, 48	7, 46 4, 37, 41, 31	14
2	Desire to learn	-Consistency -Intrinsic and extrinsic motivation -Willingness to learn	20, 25, 33, 39 3, 13, 32, 34, 36 17, 19, 21, 22	12, 18 14, 16 23, 35	19
3	Self-control	-Self-control -Ability to make decisions -Mindset	11, 24, 8, 30, 44, 45, 52	43,51 15	11
4	Motivation	-Curiosity -Interest -Get to know your own needs	9, 26, 27, 40, 29, 50	49 41, 28	9
		Amount	36	16	52

The validity test of the self-directedness scale instrument included content validity from experts, with validators in the language field, validators in the substance/content field, psychologists, and validity of the construction/arrangement of the instrument. Input, suggestions, and assessments provided by experts were used as material for researchers to revise statements on item numbers that were deemed inappropriate. The expert test results were analyzed using Aiken's V

formula. The following is Aiken's V formula used to test the validity of the self-directedness scale (Azwar, 2012).

$$V = \frac{\sum s}{n\,(c - lo)}$$

Information:
s = r – lo
lo = The lowest validity assessment number (in this case = 1)
c = The highest validity assessment number (in this case = 5)
r = Number given by an appraiser

The self-directedness instrument was declared valid with a score of 0.93 and included in the very high category. The instrument was tested on a different sample from the research sample used. It aims to find an instrument that can be generalized to the population. The next step was to calculate the internal consistency index, which is the correlation coefficient between the score of an item and the total score, which functions as the validity of the items in the affective domain instrument and is calculated using the product moment correlation formula (Budiyono, 2019).

$$rxy = \frac{n(\sum XY) - (\sum X)(\sum Y)}{\sqrt{(n\sum X^2 - (\sum X)^2)(n\sum Y^2 - (\sum Y)^2)}}$$

Information:
rxy = internal consistency index for item i
X = score for item i (from test subjects)
Y = total score (from test subjects)
yi = score on each item in the next trial
n = number of subjects subjected to the instrument

If the internal consistency index for item i is less than 0.3, then that item must be discarded (Budiyono, 2019). The results of calculating the internal consistency index for each item on the self-directedness scale showed that 13 items did not meet the requirements because they had a score of less than 0.3, so these items were discarded.

The stage of determining the reliability of the self-directedness scale instrument used the Cronbach Alpha formula and showed the same results, namely 0.816; because the results showed a score of >0.7, so the instrument was said to be reliable.

The researchers compared the instrument's contents with the subject matter that they had learned (Sugiyono, 2017). In this research, construct validity used the principles of confirmatory factor analysis (CFA) using the LISREL software. The following are the results of the analysis using the LISREL software.

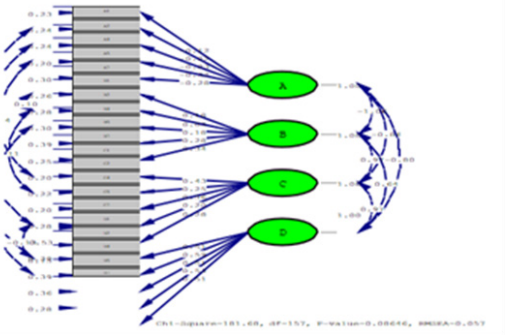

Figure 2. Path Diagram of Confirmatory Factor Analysis

The path diagram showed that the p-value = 0.08464 ≥ 0.05. This can be assumed that the model matched the empirical data. Next, the results of RMSEA = 0.057, which was slightly above 0.05, indicated that the value was good enough to show that the model matched the empirical data (Budiyono, 2019).

Based on validity and reliability tests that researchers have carried out on the self-directedness scale, 32 of the 52 statement items are valid, while 13 are declared invalid because they do not meet the predetermined value.

The first step is to provide a self-directedness scale using a questionnaire before the learning process begins. This was done to determine the level of self-directedness of students in each class, both in the control class and the experimental class. Then, each class received treatment with details of the control class applying the direct learning model, while the experimental class received the think pair project share learning model.

At the data analysis stage, before testing the hypothesis, it was necessary to test the prerequisite analysis. The prerequisite analysis tests included normality and homogeneity tests. In this research, the data normality test used the Lilliefors test, and the homogeneity test used the Levene test. The final analysis used an independent samples t-test to determine whether there was a difference and a one-sample t-test to determine the effectiveness of the think pair project share model on student self-directedness.

The category of student self-directedness level above is obtained based on the value obtained by the student (x) and compared with the average ($\bar{x}$) and standard deviation (SD) obtained from all student data.

Table 2. Categorization of Self-Directedness Levels

Level of Self-directedness	Provision
High	Score of self-directedness (x) ≥ + SD
Middle	- SD < score of self-directedness (x) < + SD
Low	Score of self-directedness (x) ≤ - SD

(Anwar, 2020)

The hypothesis of this research is:
H0: There is no significant difference in the level of self-directedness of prospective science teachers between the group that uses the Think-Pair-Project-Share (TP2S) learning model and the group that uses the conventional learning model.
Ha: There is a significant difference in the level of self-directedness of prospective science teachers between the group that uses the Think-Pair-Project-Share (TP2S) learning model and the group that uses the conventional learning model. The group that uses the TP2S model will have a higher level of self-directedness.

RESULTS AND DISCUSSION

The self-directedness scale measures students' self-direction. Data regarding student self-directedness were obtained based on the scores obtained by the research sample, namely the control class (class 2A students) and the experimental class (class 2C students). The self-directedness scale in the control and experimental classes was used before treatment.

The frequency distribution of the student self-directedness scale results in the control class is as follows.

Table 3. Frequency Distribution of Self-Directedness Scale Scores of Students in the Control Class

Interval Class	f	F (%)
58,75-63,75	1	2,77778
64,75-69,75	1	2,77778
70,75-75,75	3	8,33333
76,75-81,75	12	33,3333
82,75-87,75	13	36,1111
88,75-93,75	6	16,6667
Amount	36	100

The frequency distribution of student self-directedness scale scores in the experimental class can be presented as follows.

Table 4. Frequency Distribution of Self-Directedness Scale Scores of Students in the Experimental Class

Interval Class	fi	fi(%)
67,5-71,5	3	8,3333
72,5-77,5	5	13,889
78,5-83,5	11	30,556
84,5-88,5	12	33,333
89,5-93,5	3	8,333
94,5-98,5	2	5,555

The normality test is carried out before the homogeneity test and balance test. Its purpose is to determine whether the samples in the control and experimental classes come from a population with a normal distribution or not. The normality test used the Liliefors method with $\alpha = 5\% = 0.05$. The following results are obtained based on the normality test carried out by researchers.

Table 5. Summary of Normality Test Results

Normality Test						
Class	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Experimental Class Pretest	.099	336	.200	.948	36	.223
Experimental Class Posttest	.122	336	.200	.968	36	.607
Control Class Pretest	.115	336	.200	.958	36	.391
Control Class Posttest	.159	336	.120	.946	36	.217

Based on Table 5 above, the normality test results of this research are normally distributed because they have a Sig. ≥ 0.05.

The homogeneity test is carried out after the normality test using the Bartlett test with α = 5% = 0.05 and the Chi-Square test statistic (x2) in both the control and experimental classes. The following results are obtained based on the homogeneity test carried out by researchers.

Table 6. Results of Homogeneity Test of Variances

Homogeneity of Variances				
	Levene statistic	df1	df2	Sig.
Based on mean	.395	1	72	.533
Based on median	.374	1	72	.544
Based on the median and with adjusted df	.374	1	72	.544
Based on trimmed mean	.417	1	72	.522

Table 6 shows that the samples in both the control and experimental classes come from a homogeneous population. The paired sample T-test is used to see the difference between before and after the treatment in the experimental class with the TP2S learning model and the control class with the problem-based learning model. Data from the paired sample t-test results can be seen in the following table.

Table 7. Results of Paired Sample T- Test

Paired Samples Test								
Paired Differences								
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Experimental Class	-17,4	14	2,8	-23,1	-11,6	-6,2	36	.000
Control Class	-13,1	16	3,1	-19,7	-6,5	-4,1	36	.000

Based on the results of the paired sample T-test, it can be seen that both experimental classes got a Sig. (2-tailed) 0.000. It can be concluded that the paired sample T-test value in experimental class 1 is 0.000<0.05, so there is a significant difference in results between the pretest and posttest scores. Furthermore, the paired sample T-test value in experimental class 2 is 0.000<0.05, so the results are significantly different between the pretest and posttest scores. So, H0 is rejected. There are differences in self-directedness between students studying human and environmental courses with the think-pair-project-share model and those using conventional models.

Ruttencutter (2018) argues that self-directedness has a close relationship with aspects of grit, namely consistency of interest and persistence of effort. This research proves that someone with good self-directedness will use the results of evaluations in their learning to assess their achievement in pursuing initial goals. These results also support research conducted by Teal et al. (2015), which states that there is a strong relationship between self-directed learning and grit,

between aspects of self-control and consistency of interest and persistence in trying. Lee and Jang (2018) find that there is a positive relationship between self-directed learning and grit, growth mindset, and hope.

The results show that student self-directedness is higher in learning using the think-pair-project-share (TP2S) model in the experimental group compared to the control group with the conventional models. The TP2S learning model is developed to divide students into small groups to increase overall effectiveness. Independent learning skills have much to do with lifelong learning habits and workplace skills such as creativity, communication, and collaboration. Students should learn how to develop metacognitive learning strategies independently rather than being taught (Mercado, 2024). The four essential elements, namely group formation and management, student responsibility for the quality of individual and group work, students must be able to receive frequent and timely feedback to make them more responsible, and provided design assignments should encourage learning and team development (Tanujaya & Mumu, 2019). The team is the first step to fostering students' interest in learning the principles of knowledge by connecting knowledge with current problems in social life. However, the success of a learning program depends on the teacher's ability to manage learning, where he or she acts as the front guard in determining the success of the learning process (Tjabolo, 2020). Despite having a significant role, the teacher's task in this learning model is merely to briefly convey material, ask for a problem, and then supervise students to think more deeply about the materials described and experienced (Tanujaya & Mumu, 2019). The following is an explanation of the implementation of the TP2S model for each syntax.

In the first stage (think), a lecturer asks open questions for students to answer. However, students are previously given time to think individually and then write down their thoughts (Lightner & Tomaswick, 2017). Students think independently that the questions asked in this regard will form their ideas. The thinking time given at this stage allows students to search for more information and new knowledge to develop further answers with arguments based on their concepts (Radhakrishnan, 2019). After that, the ideas they have written are conveyed to the lecturer before continuing to the next stage (Wuryandani & Herwin, 2021). The thinking stage is the stage that instills habits for students to be able to analyze information in a short time (Raba, 2017). The information provided reveals daily real problems that occur among students. It helps students stimulate their critical thinking skills in solving these problems (Yuan, H., 2008). Another goal of this stage is to get students involved directly with an idea and then explore their knowledge to practice their ideas with a friend in a group (Cooper et al., 2021).

Based on the description above, at this stage of thinking, students are taught to start the habit of analyzing information in a short amount of time. The time given allows students to develop answers to questions given by lecturers based on concepts they have learned before. This stage aims to stimulate students' development of critical thinking skills in solving problems. In addition, this stage also encourages students to be involved directly with an idea that can be practiced with a group of friends later.

At the next stage (pair), a lecturer asks students to pair up, unite, and discuss the ideas designed beforehand. Exchanging opinions to solve problems with peers aims to develop expertise and higher-order thinking skills (Silva et al., 2022). Students discuss with their friends in pairs. Exchange information, experiences, etc., and produce various solution options that students can choose and apply to solve a problem (Abidin et al., 2018). In discussion activities, several thinking skills are required, such as the opportunity to think individually, in pairs, and in groups in the problem-solving process. Apart from that, students are more able to give opinions and respond to other people's opinions and can help each other. This increases students' critical thinking skills (Siswati et al., 2023). These skills are the foundation for students to develop their critical thinking skills. Critical thinking is an ability that encourages students to analyze, evaluate, and reason. The way for students to think critically is by getting maximum learning outcomes; teachers need to create strategies to stimulate students' critical thinking skills (Mayang et al., 2021).

At the pairing stage, the ability to communicate ideas is essential so that other people can understand the intention and purpose of the communication (Mundelsee & Jurkowski, 2021). Group activities will provide space for students to find deeper meaning in the knowledge they have and can improve their thinking skills. The most influential group work involves students with higher levels of thinking (Gautam, 2018). Students can have more space for questions and answers, input, and clarification by group mates and the lecturer by talking about what they have read. In addition, from the ideas shared by their group mates, students can gain broader experience and see the meaning of the topic raised from a different perspective (Ugwu, 2019). By implementing the paired approach, we can increase opportunities for students to have disciplined discussions about their learning with subject teachers, so students continue to engage in disciplined discussions even after they have completed their first lesson, helping to increase motivation to improve education (Wevill & Savage, 2019)

Based on the description above, students form teams in pairs to discuss ideas from their thoughts at this pairing stage. The discussion activity aims to get the most correct and appropriate answers related to the questions given by the lecturer. Discussing specific problems can help students hone their expertise and skills in higher-order thinking. Another benefit of being involved in discussion activities is getting a broader experience and having a different point of view from the ideas shared by group mates.

The next stage (project) is an additional step in the think-pair-share model. Students in groups consisting of a combination of several pairs are asked to make a project based on the results of the discussions previously carried out. Thus, students can find several different ideas from students in a group with the same goal. This activity can build students' abilities by involving collaboration between individuals to produce real work that can be demonstrated (Singh, 2023). Encouraging students to demonstrate higher abilities increases their ability to solve real problems, motivates them to increase their knowledge, meet their needs with various creativity skills, and experience the benefits of being creative (Ummah et al., 2019). Students can discuss in groups to complete projects and presentations. This method improves innovative character, creates an active learning process, and produces flexible learning (Salma et al., 2021). Project-based learning will help students improve interpersonal relationships and social skills, provide a more interesting and meaningful learning experience (Wijaya et al., 2021), and provide opportunities for students to build knowledge and understand concepts by learning independently and producing a product (Mustikaningrum., 2017). Project-based learning is one of the many ways to enhance creative problem-solving skills. The teacher's responsibility is to assist and encourage students to learn more. This can be achieved by providing them with learning tools to leverage the information they have learned and acting as advisors to put ideas into action to produce productivity and results (Plailek et al., 2023).

Group work engages students to improve the quality and challenge of assignments that students have experienced, giving students opportunities for cooperative learning. In this case, independent learning is when students are encouraged to discuss solution options in groups (Situmorang, 2021). Collaboration is critical, especially when answering questions about problem-solving situations raised during class discussions (Florungco, 2022). The project phase will provide opportunities for students to gain academic knowledge, academic literacy, and motivation due to interactions with other individuals who have completed the given project. Apart from that, students are encouraged to be open in their thinking to explore their abilities because of the situations that occur in their group (Swanson et al., 2019).

Based on the description above, forming groups aims to produce a product from the results of joint creativity. This stage raises the attitude of working together between individuals to produce real work that can be shown. This stage has the potential to provide interesting and meaningful learning experiences and encourage students to have an open mind in exploring the situation in their group.

The final step is sharing, where a lecturer asks all groups to convey and share what they have discussed with the class. This activity can help students improve their speaking skills and support the emergence of self-confidence (Cahyani, 2018). Lectures can conduct this stage effectively by going around the room from group to group until all groups get a chance to report the results of their discussion. This step allows students to get used to sharing with other students so that they can learn to minimize their selfishness through implementing this learning model (Wuryandani & Herwin, 2021). In this model, knowledge sharing, collaborative learning, and collaborative writing are considered as external factors that influence perceived usefulness and perceived ease of use, while the latter two mediate the relationship between external factors and perceived ease of use (Du & Dewitt, 2024)

At this stage, all students are involved in the discussion, including those who may be more silent and tend to avoid sharing their opinions without being asked in classes (Rempel et al., 2023). This method is considered more effective and essential for improving students' skills than studying separately. Ensure students apply deeply collaborative and constructive learning with a learning-based approach to real and relevant problems and questions (Suartama et al., 2022). Collaborative learning provides a space where learners can share knowledge, organize their thinking as part of an exchange process, and learn from others. As they cannot experience everything themselves, they must be able to acquire the knowledge, ideas, and actions of others by integrating, sharing, enriching themselves, and gaining recognition from others (Kwiatkowska & Wiśniewska-Nogaj, 2022). Sharing the ideas they have aims to make more important information about the topic given by the lecturer. This strategy allows all students to share and express their ideas with other students. This activity can increase students' sense of involvement in more challenging classroom learning activities (Tampubolon & Panjaitan, 2019).

Based on the description above, the sharing activity aims to help students improve their speaking skills and support the emergence of their self-confidence. This trains students to get used to sharing with other students to suppress their selfishness. All stu-

dents are involved in the joint discussions, including quiet ones who tend to avoid sharing their opinions without being asked in classes. In addition, this activity also aims to make more critical information about the topic given by the lecturer.

The TP2S learning model provides facilities for students to interact with all learning environment elements. In this instance, the lecturer serves as a motivator, mediator, and facilitator. Because of this, lecturers need to add to the reference materials utilized in their lesson plans by drawing from reliable reference books or research findings. In order for students to enhance their analytical skills based on the lecturer's stimulation, the learning materials must also include contemporary topics. After that, students identify and collect information to solve problems, build new insights, and improve thinking and problem-solving skills. This project-based learning model can empower students because it is student-centered during the learning process (Wijayanti et al., 2018). The TPS strategy helps students achieve a deeper level of understanding, thus making reading more attractive, enjoyable, and productive. Students who struggle with reading can be motivated through peer instruction and group discussion due to the many benefits of collaborative learning (Quazi, 2020).

CONCLUSION

The think-pair-share (TPS) learning model can be modified by adding project activities that become think, pair, project, and share (TP2S). Lecturers can apply the think-pair-project-share model as an alternative to innovative and creative learning models. This research reveals that students' self-directedness in learning human and environmental subjects with the think-pair-project-share model is higher in the experimental class than in the conventional model in the control class. The t-test result shows a significant difference between the experimental and control classes. On average, the value of self-directedness of students in learning human and environmental subjects with the think pair project share model in the experimental class (13.281) is higher than the conventional model in the control class (2.052). Therefore, the students' collaboration skills in the experimental class are better than those in the control class.

Based on the conclusions of the research results, it is known that the application of the TP2S learning model affects the self-directedness of prospective science teachers. The results of this research corroborate and bolster the result of theoretical research demonstrating the advantages of implementing the TP2S learning model. Specifically, it helps enhance students' capacity to manage their own learning so they can take the initiative, either on their own or with assistance, to assess their own learning needs, create learning objectives, find relevant sources of information, choose and implement effective learning strategies, and generate outcomes.

Applying the TP2S learning model has real benefits in increasing student independence. The problem of low student self-directedness can be overcome by implementing innovative learning, prioritizing the active role of students, and making students the center of learning (student-centered learning), such as the TP2S learning model. The TP2S learning model is an alternative solution to the problem in question. This can be proven based on the results of the marginal experimental class average, with the application of the TP2S learning model being more significant than the marginal control class average. The TP2S model provides opportunities for students to play an active role during the learning process and collaborate with other students in solving the problems they face, thereby increasing student self-directedness.

The present research is confined to prospective science teacher education programs with small sample sizes. As a result, the researchers have little control over other factors that influence student self-direction. Thus, future studies should look into other aspects that can influence student self-directedness. Future researchers should additionally consider learning models such as family history, environmental interactions, intellect, and other relevant factors.

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