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DETERMINING STUDENTS' HIGHER THINKING SKILLS PROFILE USING CREATIVE PROBLEM-SOLVING MODEL INDICATORS INTEGRATED WITH PREDICT-OBSERVE-EXPLAIN

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ABSTRACT

This study intends to investigate the profile of students' higher-order thinking skills through the model integration of Creative Problem Solving Predict-Observe-Explain (CPSPOE). Data collection was carried out both quantitatively and qualitatively (mixed method). The mixed method sequential explanatory design consisted of two distinct phases: quantitative and qualitative. In this design, the researchers first collected and analyzed quantitative (numeric) data, then proceeded with qualitative data to help decipher the quantitative results. Using a purposive sampling technique, the research sample used two junior high schools in the city of Bengkulu to determine the experimental and control classes in each school based on the average academic scores before the study. The research instrument was a high-level thinking cognitive test in the form of 10-item test items describing the interaction of living things with their environment. The results of student scores on the test were analyzed using the MANOVA significance test and obtained a p-value <0.05, meaning that there is a significant influence on classifying, problem-solving, generating hypothesizing, and decision-making. Based on the CPSPOE model reference, which is integrated with a complete and interactive sequence of learning stages that can facilitate students to be involved in efforts to train higher-order thinking skills and can effectively activate students, being facilitated by teachers, complex social systems are considered practical and easy to implement to train high-level thinking skills. This study concludes that the sequence of learning stages of the CPSPOE model can be effective in improving classifying, problem-solving, generating hypothesizing, and decision-making skills for junior high school students' high-level thinking skills.

Keywords: creative problem solving; higher order thinking skills; predict-observe-explain

INTRODUCTION

The educational paradigm contained in the 21st Century Skills must carry out thinking processes in problem-solving (Karaca-Atik et al., 2023). To compete, students must have the ability to think; they are allowed to think higher when facing difficult questions and can produce solutions to solve questions or problems (Saido et al., 2015; Colin et al., 2016). High-level thinking is scientific performance as a foundation in science learning, especially science education, to create quality, adaptive, and competitive human beings to face various challenges (Tupsai et al., 2015). According to the findings of Lee and Choi's (2017) research, students who have difficulty producing ideas would have technical challenges completing student tasks. This is an important determinant of student achievement. As a result, students must develop thinking skills to overcome obstacles in developing ideas. Higher-order thin-

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king skills are necessary since they assist students in completing tasks. Students, for example, must be helped to develop higher-order thinking skills through traditional instruction, the learning environment, or individual assignments. The goal is to instill thinking skills, problem-solving skills, independent learning, making the right decisions based on analysis, critical thinking, reasoning skills, and creative thinking (Lister, 2015; Hu et al., 2017; Kwangmuang et al., 2021). Many higher-order thinking skills principles are applied to students' academic development. For many years, these principles have been examined and employed in the classroom for teaching and learning, as well as a study on factors that contribute to the growth of students' higher-order thinking skills (Uzuntiryaki-Kondakçi & Çapa-Aydin, 2013; Gilhooly et al., 2015; Varas et al., 2023). Many elements promote higher-order thinking skills, according to the thinking process literature: school environment, family characteristics psychological features, and intelligence level (Fearon et al., 2013; Pascarella et al., 2013; Lin et al., 2021). The factors listed above should be incorporated into the learning model, which will aid in the cultivation of higher-order thinking skills (Budsankom et al., 2015).

The findings of international research institutions and national assessments demonstrate that students' higher-order thinking skills are inadequate because the learning process does not fulfill the criteria and demands of 21st-century education (Murphy et al., 2013; Lee & Choi, 2017; Puspendik, 2019). According to the International Association for the Evaluation of Educational Achievement (IEA), students' limitations in working on Trends in Mathematics and Science Study (TIMSS) questions are in analyzing and reasoning. Indonesia has a creativity score of 0.20 and is placed 115th out of 139 countries, placing it lowest in Southeast Asia (Florida et al., 2015). Several problem-solving studies involving 543 middle school students and 277 high school students reveal the part of the problem-solving process when defining the problem, looking for alternative solutions, assessing their potential consequences, and then deciding which one to use and when to apply it. The presence of impulsive problem-solving behavior is mainly dictated by negative emotions, tends to focus on one's own goals and interests, makes decisions swiftly, acts rashly, looks at only a few alternatives, and rarely considers potential consequences, if any, and, as a result, behavior may frequently turn aggressive (Fejes et al., 2023). Molnár et al. (2013) conclude that problem-solving skills are fixed and cannot be modified in a study on the development of problem-solving skills. Other studies contend that problem-solving skills evolve throughout time and can be adjusted, allowing for opportunities for improvement through focused educational interventions when problem-solving skills increase significantly (Amalina & Vidákovich, 2023; Maker et al., 2023). It is critical to practice problem-solving skills. According to Kupers et al. (2019), most research conceptualizes and examines student creativity as a static construct, although there are few studies that focus on student behavior while working on a task. To improve primary school students' creative problem-solving results, it is necessary to first understand their creative problem-solving process (van Hooijdonk, 2023). Furthermore, the results of previous studies can still be debated, so a comprehensive study is needed to develop creative problem-solving skills.

Those facts show the need for an effective learning model for high-level thinking for junior high school students in line with the 2013 curriculum. It is necessary to adjust the curriculum and teaching in the future, which is oriented toward empowering students' thinking skills in learning science. The problem-solving learning model that supports higher-order thinking is creative problem-solving (CPS) (Barak, 2013; Tseng et al., 2013). Systems vary with unusual ideas for evaluating, developing, and implementing effective solutions (Isaksen & Aerts, 2011). CPS can train mathematical principles, train students' critical thinking and problem-solving skills, reinforce them to think systematically and logically based on available data or facts, and prepare them to interact with one another based on the stages (Baumgartner, 2013; Hooijdonk et al., 2020), and can solve problems by generating various ideas and selecting the right solutions to be implemented in real-time.

The CPS framework continues to be developed by Isaksen et al. (2010), Isaksen and Treffinger (2004), and Treffinger (1995). The created CPS model includes three main components: (1) understanding the challenges, (2) generating ideas, and (3) preparing for action. The stages of understanding challenges are orientation, preparation, and the building of opportunities to set up ideas. From a psychological aspect, Saido et al. (2015) state that it is critical to understand the cognitive structure of a problem situation explicitly and definitively when confronted with new challenges during the problem-solving process. The problem-solving stage fosters creativity, and CPS points out the use of divergent thinking (Precourt, 2013; Gralewski & Karwowski, 2019). CPS emphasizes various possible flexible steps before selecting or implementing solutions and solving problems with systematic thinking (Ndiung et al., 2021). However, based on several case studies and literature, its application in the classroom shows several weaknesses in the CPS model that must be corrected (Sophonhiranrak et al., 2015). So, the CPS applied by the teacher accommodates solutions for students.

In overcoming this, a learning model is needed that has characteristics and advantages as a solution to these problems, learning that can increase understanding of scientific concepts, explore prior knowledge, teaching skills, and inspire students to carry out investigations (Hong et al., 2021; Wang & Wang, 2023). The POE model relies on Jerome Bruner's constructivist point of view as a core concept, believing that students are not just passive users of knowledge in a relatively dynamic student class, but are also capable of producing student learning (Hilario, 2015). Adebayo's (2015) research results also show that teachers can use the POE model to design learning activities that begin with the student's point of view. Students forecast outcomes, analyze reasons for their predictions, observe, and lastly explain differences between student predictions and observations in POE (Hong et al., 2021). This can expose students' prior knowledge to the instructor, allow them to interpret new observations of students of the world around them, and then offer more opportunities to share and negotiate their interpretations. According to Venida and Sigua (2020), the POE learning paradigm can help students comprehend science topics, examine students' prior knowledge, offer teachers relevant information about students' thinking skills, prepare students to participate in discussions, motivate students to explore concepts they have and stimulate students to conduct investigations. In instructional practice, encouraging students to think and learn independently is the foundation for developing a scientific attitude (Budsankom et al., 2015; Tsai, 2018). Students' interest and motivation for exploring science may have risen. Based on the facts and ideal conditions, there are gaps in research problems that need learning model integration.

The CPSPOE model is based on the condition of students' difficulties in assimilating new knowledge into cognitive schemas in the process of accommodation shown as conflict, so that in improving higher-order thinking skills only limited to thinking results without considering the process, a model is needed that has a balance between divergent and convergent thinking, namely the CPSPOE model in its application. With the integration of model development that emphasizes the thinking process, inviting students to always actively think both in a divergent and convergent manner, learning is meaningful because students experience and find their own concepts that integrate the environment and high-level thinking skills according to the characteristics of the 21st century. The need for the development of the CPSPOE model as a form of integration of the CPS and POE models, which produces 6 (six) syntaxes in which students continuously cultivate higher-order thinking skills in an orderly manner through scientifically structured syntax, namely, problem stimulation, problem finding, prediction, idea finding, solution finding, is explained as a novelty in this research. Constructivism-oriented learning based on problem-solving is a characteristic of scientific learning activities through an environmental approach that is contextual with real life and meaningful because students experience it directly, as well as more complex social systems that integrate the environment and society. The CPSPOE integration is implemented into learning components which, in carrying out science learning activities, are based on various learning theories by Ausubel, Bruner, Piaget, and Vygotsky to facilitate students in exploring thinking processes more optimally, implementing science learning activities to improve classifying skills including problem-solving, generating hypothesizing, and decision making effectively.

METHODS

Because the quantitative data in the subsequent analysis provides a general grasp of the research's problems, this design technique was used. In the second phase of the sequence, qualitative data was collected and analyzed to assist explain or elaborate on the quantitative results acquired in the first phase, and the analysis clarified and explained those statistics by investigating participants' perspectives in greater depth (Creswell, 2013; Ivankova & Plano Clark, 2018). The stages were as follows: 1) Planning. Preparation of the CPSPOE learning model, developing and validating instrument collection data; 2) Implementation of learning. This stage included many steps: a pretest before learning, learning implementation, and a posttest after learning; 3) Post Implementation. To complement the results of the student perception survey, student perception questionnaires and semi-structured interviews were conducted, and 4) analysis and interpretation of research data. The implementation of a sequential explanatory design began with the gathering and analysis of quantitative data, followed by the collection and analysis of qualitative data that expanded on the quantitative data's initial results (Earley, 2014; Ivankova, 2014).

Data were collected in each experimental and control group in approved schools. Before receiving treatment, both the experimental and control groups were required to complete a pretest. The pretest results were good when the experimental group's scores were not significantly different, as shown in Table 1. The CPSPOE learning model was used to teach students in the experimental group, whereas the conventional model was used to teach students in the control group.

Table 1. Initial Data of Similarity Test

Tests of Between-Subjects Effects						
Source	**Dependent Variable**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected indicator	Classifying (Y1)	.048[a]	1	.048	.129	.321
	Problem-Solving (Y2)	.358[b]	1	.358	1.008	.119
	Generating Hypothesizing (Y3)	.007[c]	1	.007	.026	.173
	Decision Making (Y4)	.000[d]	1	.000	.000	.046
Intercept	Classifying (Y1)	241.752	1	241.752	647.857	.000
	Problem Solving (Y2)	296.358	1	296.358	834.128	.000
	Generating Hypothesizing (Y3)	344.937	1	344.937	1267.221	.000
	Decision Making (Y4)	260.451	1	260.451	836.143	.000
X	Classifying (Y1)	.048	1	.048	.129	.321
	Problem Solving (Y2)	.358	1	.358	1.008	.119
	Generating Hypothesizing (Y3)	.007	1	.007	.026	.173
	Decision Making (Y4)	.000	1	.000	.000	.046
Error	Classifying (Y1)	25.748	69	.373		
	Problem Solving (Y2)	24.515	69	.355		
	Generating Hypothesizing (Y3)	18.782	69	.272		
	Decision Making (Y4)	21.493	69	.311		
Total	Classifying (Y1)	267.500	71			
	Problem Solving (Y2)	321.000	71			
	Generating Hypothesizing (Y3)	363.750	71			
	Decision Making (Y4)	282.000	71			
Corrected Total	Classifying (Y1)	25.796	70			
	Problem Solving (Y2)	24.873	70			
	Generating Hypothesizing (Y3)	18.789	70			
	Decision Making (Y4)	21.493	70			

Table 1 shows that the calculated F value is 0.149 with a p-value of 0.321 > 0.05, then H0 is accepted, which means the difference is not significant. The value of F_{count} is 1,008 with a p-value of 0.119 > 0.05, then H0 is accepted, which means the difference is not significant. The F_{count} value is 0.026 with p value 0.173 > 0.05, then H0 is accepted, which means the difference is not significant. The value of F_{count} is 0.000 with a p-value of 0.046 <0.05, then H0 is accepted, which means the difference is significant. The initial data of the similarity test for four indicators (classifying, hypothesizing, problem-solving, decision-making) shows that there are three indicators with insignificant initial data differences, meaning that there are similarities in initial data, and one indicator (Decision-Making Y4) with significant differences meaning that there is no initial data similarity, although thus it can be assumed that on average the initial data of similarity test has been fulfilled. After testing the similarity of the initial data, each group was given a different treatment. The control group followed the conventional learning model, while the experimental group applied the CPSPOE learning model. For more details, the Nonequivalent Control Group Design (Budiyono, 2017; Ivankova & Plano Clark, 2018) is presented in Table 2.

Table 2. Research Design

Experiment Class	O1	CPSPOE	O2
Control Class	O3	conventional	O4

It was conducted in two junior high schools with 139 samples applied to class VII students of SMP A and SMP B. After approval by the ethics committee and the principal, data was collected on all students in the participating schools, and scores were confirmed by written consent. Data collection was carried out quantitatively and qualitatively (mixed method) (Ng & Smith, 2017). The material was focused on four sub-materials or four meetings using test materials for the interaction of living things with their environment. The researcher developed a test instrument with ten descriptive questions that had been tested for product efficacy through content validation to 6 technical expert assessment experts (with a minimum Doctoral qualification). Observations of thinking processes, interviews, and questionnaires were also carried out using observation techniques for qualitative data. The achievement of the higher order thinking skills questionnaire consisted of 35 questions, which then used 20 questions consisting of 13 positive statement questions and 7 negative statement questions. From 35 items of questions, 8 items have an infit value < 0.7, 21 items have a range of 0.70 ≤ infit value ≤ 1.30, and 5 items have an infit value > 1.30, so the resulting item questions are 21 items. In addition, participants could end the survey or skip questions at any time.

A questionnaire about students' impressions of the CPSPOE learning model was used to collect qualitative data, supplemented by semi-structured interviews using audio recordings of students who volunteered. After implementing learning, a student perception questionnaire was conducted. The researchers created a questionnaire, verified and evaluated it with a Cronbach's Alpha reliability rating of 0.869. The instrument is reliable (Taber, 2018). In addition, participants could end the survey or skip questions at any time. Assessment of product effectiveness of the CPS-POE model used a description test instrument. Rationally, integrating the CPS model and the POE model brings the same characteristics but with a different emphasis on the two models. This can be seen in the two models being information processing models, namely learning models that focus on activities related to information processing activities to improve students' skills through the learning process (Joyce et al., 2003). Integration of Creative Problem Solving (CPS) with the concept of Predict, Observe, Explain (POE) or CPSPOE elaborates problem stimulation, problem finding, predicting, idea finding, solution finding, and explaining, and the CPSPOE matrix to improve classifying, generating hypothesizing, problem-solving, and decision-making.

Data analysis in this study used the MANOVA method to calculate the test of significance of differences in the mean simultaneously between groups for two or more selected variables. The standard normal distribution is defined as data transformed in the form of a Z-Score and assumed to be normal. If the significance value is above 0.05, then the data being tested is said to be normal. A homogeneity test is a test conducted to find out that two or more sample data groups come from populations that have the same (homogeneous) variance, one way is to use the Levene test. If the significance of homogeneity is greater than 0.05 (sig>0.05), then the variables in both groups (experimental and control) are declared homogeneous. After being declared normal and homogeneous, it proceed with the MANOVA test (Gamage et al., 2004; Xu, 2015). The feature of MANOVA is that there can be more than one independent variable, but there must be more than one dependent variable. This test was used to test the effectiveness of the CPSPOE model on the ability to classify, solve problems, generate hypotheses, and make decisions. The MANOVA test used the SPSS program. In general, the research procedure is presented in Figure 1.

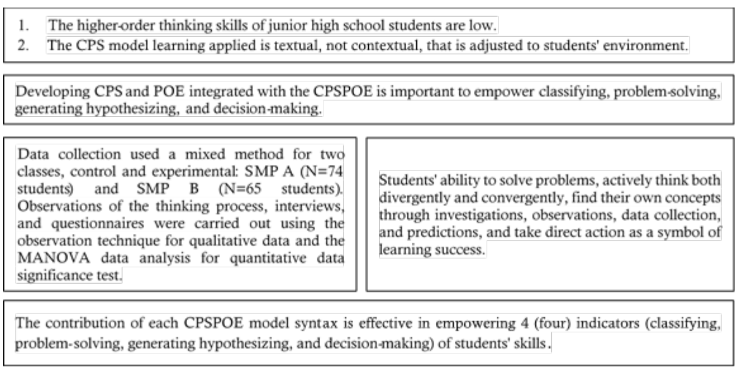

Figure 1. Research Procedure

RESULTS AND DISCUSSION

The quantitative data analysis in this study aims to test the average skill score between the experimental class using CPSPOE and the control class using the conventional model. MANOVA analysis at the significance level of 5% is used to see differences in student learning outcomes using the CPSPOE or conventional model. The results of the 10-item description test are analyzed using the MANOVA test, which previously fulfills the significance of normality and homogeneity.

The SMP A test results consist of skill variables of classifying (Y1), problem-solving (Y2), generating hypothesizing (Y3), and decision-making (Y4). The significance of the MANOVA results for SMP A can be seen in Table 3.

Table 3. The MANOVA Test of Higher Order Thinking Skills for SMP A Students

Tests of Between-Subjects Effects						
Source	**Dependent Variable**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Classifying (Y1)		1.095[a]	1	1.095	11.401	.001
Corrected Model	Problem Solving (Y2)	.338[b]	1	.338	4.199	.045
	Generating Hypothesizing (Y3)	.409[c]	1	.409	11.002	.020
	Decision Making (Y4)	.662[d]	1	.662	10.723	.029
Intercept	Classifying (Y1)	261.095	1	261.095	517.719	.000
	Problem Solving (Y2)	292.014	1	292.014	852.987	.000
	Generating Hypothesizing (Y3)	330.976	1	330.976	811.524	.000
	Decision Making (Y4)	268.662	1	268.662	698.941	.000
X	Classifying (Y1)	1.095	1	1.095	11.401	.001
	Problem Solving (Y2)	.338	1	.338	4.199	.045
	Generating Hypothesizing (Y3)	.409	1	.409	11.002	.020
	Decision Making (Y4)	.662	1	.662	10.723	.029
Error	Classifying (Y1)	36.311	72	.504		
	Problem Solving (Y2)	24.649	72	.342		
	Generating Hypothesizing (Y3)	29.365	72	.408		
	Decision Making (Y4)	27.676	72	.384		
Total	Classifying (Y1)	298.500	74			
	Problem Solving (Y2)	317.000	74			
	Generating Hypothesizing (Y3)	360.750	74			
	Decision Making (Y4)	297.000	74			
Corrected Total Classifying (Y1)		37.405	73			
Problem Solving (Y2)		24.986	73			
Generating Hypothesizing (Y3)		29.774	73			
Decision Making (Y4)		28.338	73			

Based on Table 3, X has a significant effect on Y1. The F_{count} value is 11.401 with a p-value of 0.001 <0.05, then H1 is accepted. The value of Y2 at X with F_{count} is 4.199 for a p-value of 0.045 <0.05, which means it is significant. X at Y3 has the F_{count} value of 11.002 with a p-value of 0.020 <0.05, then H1 is accepted, and X has a significant effect on Y4 with the F_{count} value of 10.723 and p-value of 0.029 <0.05, which means a significant effect.

The research sample for SMP B is 65 students. The test results are in the form of skill variables of classifying (Y1), problem-solving (Y2), generating hypothesizing (Y3), and decision-making (Y4). The significance of the MANOVA results for SMP B can be seen in Table 4.

Table 4. The MANOVA Test of Higher Order Thinking Skills for SMP B Students

Tests of Between-Subjects Effects						
Source	**Dependent Variable**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	Classifying (Y1)	.064[a]	1	.064	.164	.031
	Problem Solving (Y2)	.019[b]	1	.019	.065	.049
	Generating Hypothesizing (Y3)	.000[c]	1	.000	.000	.023
	Decision Making (Y4)	.000[d]	1	.000	.002	.016
Intercept	Classifying (Y1)	247.957	1	247.957	629.963	.000
	Problem Solving (Y2)	232.634	1	232.634	804.068	.000
	Generating Hypothesizing (Y3)	259.938	1	259.938	606.523	.000
	Decision Making (Y4)	228.923	1	228.923	2055.860	.000
X	Classifying (Y1)	.064	1	.064	.164	.031
	Problem Solving (Y2)	.019	1	.019	.065	.049
	Generating Hypothesizing (Y3)	.000	1	.000	.000	.023
	Decision Making (Y4)	.000	1	.000	.002	.016
Error	Classifying (Y1)	24.797	63	.394		
	Problem Solving (Y2)	18.227	63	.289		
	Generating Hypothesizing (Y3)	27.000	63	.429		
	Decision Making (Y4)	7.015	63	.111		
Total	Classifying (Y1)	273.000	65			
	Problem Solving (Y2)	251.000	65			
	Generating Hypothesizing (Y3)	287.000	65			
	Decision Making (Y4)	236.000	65			
Corrected Total	Classifying (Y1)	24.862	64			
	Problem Solving (Y2)	18.246	64			
	Generating Hypothesizing (Y3)	27.000	64			
	Decision Making (Y4)	7.015	64			

Based on Table 4, the CPSPOE model has a significant effect on Y1, showing the Fcount value of 0.164 with a p-value of 0.031 <0.05, so H1 is accepted, which means the effect is significant. Furthermore, the CPSPOE (X) model has a significant effect on Y2. The F_{count} value is 0.065, and the p-value is 0.049 <0.05, so the effect is significant. In Y3, the F_{count} value is 0.000, and the p-value is 0.023 <0.05, so H1 is accepted, which means the effect is significant. The CPSPOE model also has a significant effect on Y4 with an F-count of 0.002 and a p-value of 0.016 <0.05.The results of the qualitative assessment of the interview and questionnaire processes in this study are shown in Table 5.

Table 5. Achievement of Higher Order Thinking Skills Based on Questionnaires

Higher Order Thinking Skills	Achievements (%)	
	Positive Item	Negative Item
Classifying	87,8	33,8
	85,5	
	80,5	
Problem-Solving	74,5	54,1
	78,6	
	77,6	
	77,5	
Generating Hypothesizing	80,5	34,5
	78,5	54,1
Decision Making	78,4	39,0
	80,5	49,3
	80,5	46,6
	80,0	

Table 5 reveals that the achievement of higher-order thinking skills based on student questionnaires on learning science shows an average percentage of 80.0 on positive items and 44.5 on negative items. This shows that science learning gets a positive response from students. The CPSPOE model learning process can improve students' abilities in science process skills, increase students' courage in expressing opinions, ideas, and thoughts, and increase student activity in the learning process. The calculation of the MANOVA significance test in this study shows that both schools (SMP A and SMP B) obtain the result that the CPSPOE model effectively increases classifying, problem-solving, generating hypotheses, and decision-making skills.

At SMP A, the MANOVA significance test on classifying shows that the classification has the most effect with a value of 0.001 <0.05, and for SMP B, the significance test is 0.031 <0.05, which means that the CPSPOE model also has an effect on the classification. Based on research data, students can initiate ideas and connect things. Problem analysis shows students' ability to present concepts or problems and compare one part with another using logical arguments, describe the arguments used to connect the parts and form information that is collected and restructured to produce new ideas in the thinking process (Christiansen et al., 2013; Kwangmuang et al., 2021). This is based on the CPSPOE model syntax on problem stimulation, where students start with an observation and then collect as much information as possible from all perceptions and all student senses, starting with the questions 'who, what, where, when, why, and how' to identify with the most important facts relevant to challenges or problems so that students understand the learning objectives. The teacher facilitates and guides students in collecting data or information and guides students to achieve learning goals. Learning is a process whereby knowledge is created through experience transformation (Lockey et al., 2021). The teacher provides stimulation so that students interact with the environment actively, seek, observe, and find various things from the environment; this is intended so that learning becomes more meaningful through experience, knowledge, and thinking processes and can generate ideas in the form of unlimited information in information processing (Knight, 2015; Saido et al., 2015; Pozo et al., 2022). After the results are analyzed and linked to the problem, other students provide feedback so that conclusions are obtained from student problems, and they can explain the relationship briefly. Students build on an experience platform to introduce and understand new concepts, underlying this is the importance of social interaction and social processes in learning, which is carried out in the discussion. Then, the teacher helps conclude learning activities, provides the experience of seeing and learning again through the conclusions made, and provides feedback to students to see how far students understand learning (Apostol, 2017; Montag-Smit & Maertz, 2017).

The MANOVA significance test results of problem-solving for SMP A and SMP B students are 0.045 <0.05 and 0.049 <0.05, meaning that the CPSPOE model influences problem-solving.

However, its effectiveness is low compared to classifying, generating hypotheses, and making decisions. Problem-solving skills have become important as an indicator of academic achievement in education in the science learning process; apart from applying concepts or knowledge obtained through the learning process, it is also a vehicle for acquiring new knowledge. Students must be able to explore problem situations and process and coordinate various information to find accurate solutions through unique correct solutions from various fulfillments (Lisesi, 2017; Idris et al., 2022; Daryanes et al., 2023). It cannot be denied that students in action-based thinking processes tend to prefer methods whose thinking style is comfortable for them when using skills rather than facing problems (Abu-Hussain & Abu-Hussain, 2018; Min & Kim, 2020). Interaction with the environment is essential for students' cognitive development; Vygotsky's theory contends that people consider and discuss problems in their social environments, emphasizing the importance of social interaction in cognitive growth. Face-to-face interaction with peers boosts motivation and allows students to develop connections while also emphasizing the value of teamwork (Salakhatdinova & Palei, 2015). This is consistent with Sjølie et al.'s (2022) belief that the cognitive and socio-emotional elements of social interaction are interrelated; for example, non-task interactions have been found to correlate with improved learning results, while personal well-being is linked to team performance. As a result, social interaction is critical for team performance, learning, and general well-being.

The significance of the MANOVA test of generating hypotheses of SMP A and SMP B students is $0.020 < 0.05$ and $0.023 < 0.05$, meaning that the CPSPOE model influences the students' high-order thinking skills to generate hypotheses. The CPSPOE model syntax to improve hypothesis generation is in the prediction and idea search stages. At the prediction stage, student activities provide predictions based on problems taken from student experience or books that guide an event or phenomenon found when working on it before. Through assimilation, students try to understand their environment by using existing cognitive structures or knowledge without making changes. In the accommodation process, students try to understand their environment by modifying existing cognitive structures to form new ones based on the stimulus they receive (Alanazi, 2016; Yerimadesi et al., 2023). At this stage, predicting by imagining is a form of prior assimilation and accommodation of a particular phenomenon. Students develop hypotheses and make rules about abstract things so students can predict and interpret the findings of problems from the previous stage. While the idea discovery stage is to increase the generation of hypotheses, students generate as many ideas as possible to solve problems or challenges in the previous stage by making new relationships between ideas through analogy. Students make rules about abstract things to draw conclusions, interpret, and develop hypotheses or make new associations from people's ideas (Iordanou & Constantinou, 2014; Zhu et al., 2019). In line with Bruner's theory, the teacher gives freedom to students to become problem solvers. Students are encouraged to learn independently and find ideas and answers to problems through activities and experiences. Generating hypotheses directs the thinking process toward problem solutions. Hypotheses help the investigator collect the data needed to investigate the relationship between students' attitudes and performance in turning ideas into actions to find the information needed to solve problems (Chan et al., 2022; Wakhata et al., 2023).

The MANOVA test results on decision-making in SMP A and SMP B students are $0.029 < 0.05$ and $0.016 < 0.05$, meaning that there is influence from the CPSPOE decision-making model. The effect on SMP B students is greater than SMP A students. This can happen because the school is in the high category at SMP B, with the ability of students to analyze specific problems, challenges, or questions to measure the ability to find certain parts or sections to describe parts that are related to one another is higher than that of SMP A students. Part of the CPSPOE model in this field is the search for solutions, where students use criteria to assist in carrying out the best solutions to problems or phenomena that arise in learning. Students turn ideas into action by developing and implementing action plans. Through discussion and experimentation, the teacher guides students to find the best solution criteria, and the most appropriate problem-solving assistance in the form of instructions, warnings, and encouragement is carried out by the teacher during the early stages of learning so that the longer students learn they can take responsibility independently. Teachers must be able to do scientific communication consisting of indicators for conveying ideas and opinions, explaining the process of an activity, and leading to results, conclusions, and recommendations based on data and facts or studying learning content for students (Parmin et al., 2021). Students create their knowledge through a discovery-based learning approach, which involves experimenting and inferring results through science experiments. The aspects discussed in this stage include basic conceptual themes, methodological issues, paradigms, types and stages, advantages and disadvantages, providing conceptual and epistemological influences, and predicting the pressure of epistemological shifts. It becomes important to let students create their experiments so that they do not just follow the teacher's directions; they are allowed to acquire science concepts, improve scientific processing abilities, detect difficulties that require thinking skills, and adapt quickly and accurately as a thinking process (Lor, 2017; Shana & Abulibdeh, 2020; Yeşiloğlu & Köseoğlu, 2020), the decision-making process is choosing among a series of alternatives based on the criteria provided (Ontario Public Service, 2016; Lin et al., 2021), through a thinking process that generates ideas, implements solutions, and evaluates the reasonableness of ideas, thinking skills that require more than just remembering or memorizing information (Arreola & Reiter-Palmon, 2016; Idris et al., 2022) in increasing the fulfillment of higher thinking skills.

CPSPOE empowerment is indicated by a balance of divergent and convergent thinking processes in solving each problem by using various alternative answers from different sources of information. The CPSPOE model, as a form of creative problem-solving model based on information processing, is very relevant to research results (Vernon et al., 2016; Gralewski & Karwowski, 2019; Zhu et al., 2019) which show convergent, divergent thinking activities in balance with creative science concepts and a complete understanding of concepts. Indicators of higher-order thinking skills and very complex environmental problems provide opportunities for students to find solutions to be directly involved in discovering scientific concepts through learning (Ping et al., 2020; Hong et al., 2021). CPSPOE is strengthened by creativity in the environment. In addition, skill refers to an individual's problem-solving skills that generate unusual and creative ideas (Fredriksdotter et al., 2022). Exploring alternatives to overcome deficiencies or obstacles in achieving the desired goals is part of the need for problem-solving, such as application concepts that apply creative process skills among students to solve complex problems (Runco & Nemiro, 2018). Another effect of developing thinking skills through science in schools is increasing students' interest, motivation, and curiosity about a phenomenon by connecting the knowledge students acquire at school with what they acquire in their daily activities (Jessani, 2015; Lindahl & Lundin, 2016).

The novelty of the CPSPOE model consists of 6 syntaxes, namely problem stimulation, problem finding, predicting, idea finding, solution finding, and explaining, and has the characteristics of model components, namely: 1) the social system is complex, applicable, and meaningful, namely the interaction between teachers and students in the process of stimulation, as well as guidance in solving contextual problems into scientific science. The interaction between students in gathering information based on their respective experiences, the interaction of students with the environment in the learning adaptation process of the interaction of living things with the environment; 2) the principle of reaction is investigative in collecting data and facts, formulating problems, explorative in exploring ideas, responsive, and complex in actively participating in gaining direct experience with the environment; 3) an integrated support system through module teaching materials and evaluation, as well as classroom facilities, practicum tools, and materials; 4) the impact of the CPSPOE instructional model in the form of high-level thinking skills with student achievement on all indicators and learning objectives, as well as the impact of the CPSPOE companion model which indirectly is the ability of students to carry out thinking processes in carrying out learning, and in respecting the environment. The CPSPOE model effectively improves students' high-order thinking skills (classification, problem-solving, hypothesis-making, and decision-making) simultaneously at the highest decision-making indicator at the fifth syntax stage of Solution Finding. The effectiveness of the learning model can be seen from the difference in the average higher-order thinking skills between students who use the CPSPOE model better than students who use the conventional model. The differences in results at different schools indicate the findings of the CPSPOE model that differences in student backgrounds affect students' thinking processes in classifying, solving problems, generating hypotheses, and making decisions.

CONCLUSION

The CPSPOE model can empower students' high-order thinking skills and has 6 (six) learning syntaxes, namely problem stimulation, problem finding, predicting, idea finding, solution finding, and explaining, which have their respective contributions to indicators of higher thinking skills (classifying, problem-solving, hypotheses generating, decision making). The results of the MANOVA significance test show that: 1) Classifying of SMP A and SMP B students respectively is $0.001 < 0.05$; $0.031 < 0.05$;

2) Problem-solving of SMP A and SMP B students, respectively, is 0.045 < 0.05; and 0.049 <0.05; 3) Generating hypotheses of SMP A and SMP B students, respectively, is 0.020 < 0.05; and 0.023 < 0.05; 4) Decision-making of SMP A and SMP B students is 0.029 < 0.05; and 0.016 < 0.05. Based on the MANOVA significance test results, the CPSPOE model effectively improves classifying, problem-solving, generating hypotheses, and decision-making. The contribution of the CPSPOE model encourages students to actively think in a divergent and convergent way, resulting in quality contextual learning based on the environment; learning is meaningful because students experience and find their own concepts through investigation, observation, data collection, prediction, and direct action. The CPSPOE model is not only oriented to practicum activities. Moreover, it can overcome problems that are applied in students' real lives to improve students' ability to classify, solve problems, generate hypotheses, and make decisions.

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