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Improving Students' Metacognitive Skills and Learning Outcomes Through The Application of Task-Based Learning Model of Direct Instruction

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Abstract. *The problem of low metacognitive skills and student learning outcomes on colloid topics is overcome by implementing Task-Based Learning Direct Instruction (TBLDI) models. This study aims to improve (1) metacognitive skills, (2) learning outcomes aspects of knowledge, attitudes, and skills, (3) teacher implementation in applying the TBLDI model; (4) student activity. This research was conducted using a classroom action research design in two cycles. Each cycle consisted of four stages: planning, action, observation, and reflection. The research subjects were 33 students of class XI IPA 3 at SMA Negeri 10 Banjarmasin. Data was collected using valid instruments, metacognition skills tests (V = 0.98), student learning outcomes tests (V = 0.99), and non-tests to determine the process of implementing actions. Data were analyzed using quantitative and qualitative descriptive techniques. The results of the study showed that (1) students' metacognitive skills increased from the category starting to develop to be well developed, (2) knowledge learning outcomes increased from the less to the good category, attitudes were in a good category, and skills were also in the skilled category in cycle II, (3) the implementation of the teacher in implementing the TBLDI model is very good, (4) the activity of students increases from being active in cycle I to being very active in cycle II.*

Keywords: *Colloid; Direct Instruction; Metacognitive Skills; Task-Based Learning*

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INTRODUCTION

Colloidal matter is very close to living matter. Colloidal material contains facts and thoughts that a strong memory to comprehend. There is procedural knowledge that necessitates practicum and the solution of real-world problems. This is due to the fact that the use of colloids has a lot to do with human activities, such as water purification (Hasanah & Mitarlis, 2016; Syahmani et al., 2022).

Colloid learning at SMAN 10 Banjarmasin through a lecture approach is regarded as less effective because students find it difficult to apply the material being studied to real-life circumstances. There is a lack of contextual examples, and there is not any evaluation of the assignments given. This affects students' chemistry learning results at SMAN 10 in 2021 (average score 43.55), and metacognitive skills in the category begin to develop. Despite the fact that metacognition is critical for learning science in the 21st century (Kober, 2015; Lavi et al., 2021; Negretti, 2021) that this is the key to understanding ideas, mastering, and applying science/chemistry concepts in real contexts (Dori et al., 2018; Fleur et al., 2021; Leny et al., 2020; Muhali et al., 2019; Syahmani et al., 2022; Vrieling et al., 2018). In addition, this is also an important provision to face real job demands (Cervin-Ellqvist et al., 2021).

This problem can be overcome if students have good metacognition skills (Dawson, 2008). Students' eagerness to learn will increase as their metacognition skills improve (McDowell, 2019), control their knowledge to solve problems, evaluate decisions accurately, and the extent to which learning success has been achieved (Azizah et al., n.d.; Boud & Soler, 2016; Tai et al., 2018) as well as fix the existing weaknesses (Arami & Wiyarsi, 2020).

The Direct Instruction (DI) technique can assist students in mastering fundamental skills and developing step-by-step information to boost metacognition skills and learner motivation (Zepeda et al., 2015) and can integrate the Task Based Learning (TBL) approach (Mueller & Brown, 2022) particularly appropriate for group problem solving and independent learning (Zhou et al., 2013), cognitive and communicative skills (Tonia & Ganta, 2015). The relationship between the DI model syntax, the TBL approach and metacognition skills is depicted in Table 1. The assignments used the available processes and resources to produce a product (Tekkumru-Kisa et al., 2015, 2020). This allows students to use knowledge what they have learned and apply it gradually (Buyukkarci, 2019).

Table 1 Correlation Among DI Model Syntax, TBL Approach and Metacognitive Skills

DI Model Syntax	Indicators of *Task Based Learnning*	Indicator of Metacognitive Skills
Phase 1 Delivering objectives and preparing students **Phase 2** Presentation and demonstration		**Orientation.** Orienting students on the task to be completed
Phase 3 Guiding Training	– Making a task implementation schedule and planning how to solve the problem – Developing a strategy/action plan – Collecting information/data or things related to problems to be solved. – Formulating the information/ data that has been obtained and arranged systematically. – Creating trial work steps for problem-solving – Preparing the tools and materials that have been determined.	**Arrange a strategy/action plan:** - Exploring prior knowledge as they interpret the information provided and refer to relevant concepts before developing a solution plan. - Making predictions about the information in the problem to be solved based on what has been read - Identifying information on a topic and restating it in a more operational form.
Phase 4 Checking understanding and providing feedback	- Conducting experiments, collection, and analysis of data - Presenting it	- **Monitor/control the action:** - Monitoring the implementation of actions, verify, clarify, analyze, and develop. - Presenting the results and - formulating an answer.

Phase 5 Providing opportunities for further training and application	- Concluding experimental results	**Evaluating/ assessing actions** - Evaluate success, discard inappropriate strategies

The TBLDI model is supported by Vygotsky's Socio-Cultural Theory (SCT) in which students build their knowledge through social interaction (Qin, 2017; Richard, 2012). The core of SCT is the Zone of Proximal Development (ZPD). ZPD is "the distance between the actual level of development determined by independent problem solving and the level of potential development determined through problem-solving under adult guidance or collaboration with more capable peers" (Cakir, 2008; Qin, 2017).

The ZPD concept is used to describe how students' metacognition skills evolve. The teacher assists students in metacognition and problem solving in their ZPD by scaffolding metacognitive questions (Enggen & Kauchak, 2013; Schunk, 2012).

Metacognition is "thinking about thinking" (Ku & Ho, 2010; Veenman, 2012). Metacognition consists of knowledge and metacognitive skills (Sengul & Katranci, 2012). This research focuses on metacognitive skills in three aspects: planning, monitoring, and evaluation (Herscovitz et al., 2012). Metacognition skills are related to understanding concepts (Syahmani et al., 2021), learning outcomes and problem-solving (Cooper & Sandi-Urena, 2009; Temel et al., 2012), academic success (Vrdoljak & Velki, 2012), and students' performance (Cook et al., 2013).

This investigation is likely to yield significant results. The study's intended findings are that using the TBLDI model can increase students' metacognitive skills and learning outcomes and encourage students to be more engaged and driven to solve given challenges.

Giving appropriate assignments forces students to practice metacognitive skills (Dori et al., 2018; Richard, 2012; Zepeda et al., 2015), problem-solving skills and critical thinking (Prasasti et al., 2020).

METHOD

This research used classroom action research (CAR) with the research design developed by Stephen Kemmis and Robin McTaggart. The research was conducted in two cycles, and each cycle consisted of four phases: planning, action, observation, and reflection (Hopkins, 2011). Each cycle consisted of three lessons and tests of metacognitive skills. The first cycle would analyze the properties of colloids and their uses, while the second cycle would make products based on the colloid principle.

The subjects of this study were 33 students of class XI IPA 3 at SMAN 10 Banjarmasin consisting of 16 male students and 17 female students.

This instrument in this study was in the form of tests and nontes. The test instrument used was a valid metacognitive skill test in the form of an essay with 2 questions (V = 0.98) and a learning achievement test with 10 questions (V = 0.99), while the non-test instruments were metacognitive skill questionnaire sheets, teacher and students' activity observation sheets, attitudes and skills.

The data analysis technique was in the form of qualitative descriptive analysis to analyze the results of the test and non-test data that have been collected. The qualitative data analysis was done through data display, data reduction, and conclusions. Indicators of successful implementation of the action were students' metacognitive skills, with a minimum score of 61 and knowledge learning outcomes, with a minimum score of 75 with a minimum N-gain value in the moderate category.

RESULT AND DISCUSSION

Metacognitive Skills

The results of the metacognitive skill tests of students in cycles I and II are presented in Table 2 and Figure 1. The TBLDI model enabled students to practice metacognitive skills through various activities such as planning the completion of learning assignments, selecting the appropriate strategy, monitoring learning progress and evaluating (correcting and fixing it) if any errors occur during concept understanding (Leny et al., 2020). Aspects of evaluative skills cycles I and II remain in the very risky category (VR), with only 15.81% increase. Things that need to be improved on the aspect of evaluation skills. TBLDI learning to improve metacognition skills can develop by familiarizing students in answering metacognitive questions and evaluating whether existing assignments are in accordance with the planned steps. Metacognition training proceeds and was carried out in stages so that students get used to and develop their meta-cognition properly (Iskandar, 2014). The results of metacognitive skills in cycle I were from starting to develop (SD) to be well developed (WD) in cycle II. The same thing happened to the percentage of success in achieving the completeness criteria in cycle II, indicating that the metacognitive skills had developed well.

Table 2 The Results Of Students' Metacognition Skills Tests in Cycles I and II

Metacognitive Skills	Number of Question	Score Cycle I	Category	Score Cycle II	Category	N-gain (%)	Category
Planning	1a	98.48	BSB	96.97	BSB		
	1b	96.97	BSB	96.97	BSB		
	1c	59.09	MB	84.85	BSB		
	2a	83.33	BSB	96.97	BSB		
	2b	93.94	BSB	95.45	BSB		
	2c	33.33	MSB	63.64	SBB		
Average of planning		*77.53*	*SBB*	*89.14*	*BSB*	52	Moderate
Monitoring	1d	56.06	MB	77.14	SBB		
	1e	36.33	MSB	68.18	SBB		
	2d	25.76	MSB	50.00	MB		
	2e	22.73	MSB	34.85	MSB		
Average of monitoring		*35.23*	*MSB*	*57.54*	*MB*	34	Moderate
Evaluating	1f	30.30	MSB	46.97	MB		
	2f	10.61	BB	25.76	MSB		
Average of evaluating		*20.45*	*MSB*	*36.26*	*MSB*	20	Low
Average of cycles		**44.40**	**MB**	**61.02**	**SBB**	**30**	Moderate
Completeness (%)		**44.45**	**MB**	**69.70**	**SBB**	**44**	Moderate

Note: **WD** (Well-developed, **AD** (Already developed), **SD** (Starting to develop), **VR** (Very Risky), and **ND** (Not developed)

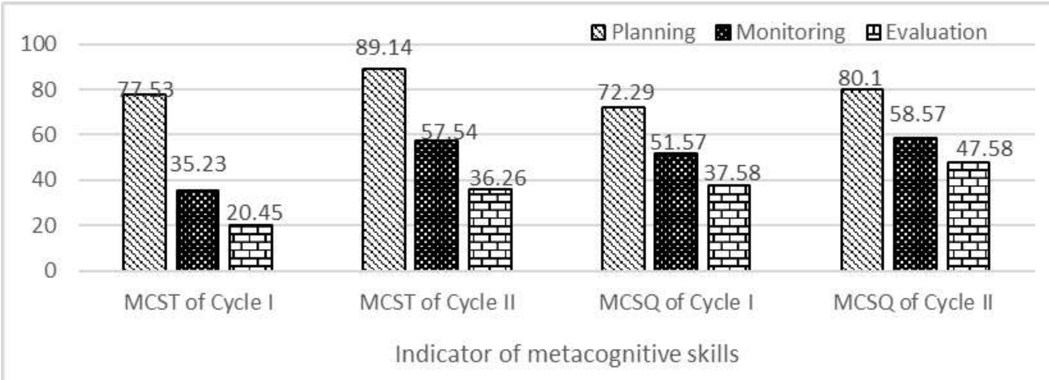

Figure 1 Comparison of Test Results and Metacognitive Questionnaires Cycle I and Cycle II

Figure 1 shows that the achievement of students' metacognitive skills on tests and questionnaires is slightly different but has the same trends, namely aspects of planning > monitoring > evaluation, with cycle II achievements being better than cycle I. The highest aspect is planning skills (score > 70) , because it is influenced by the increased understanding of students' chemical concepts. This is in accordance with the results of research conducted by (Devetak et al., 2009; Hilton & Nichols, 2011; Prain & Tytler, 2013; Syahmani et al., 2023; Talanquer, 2011; Treagust et al., 2003) that chemistry is more meaningful when interconnecting several chemical representations, to increase students' understanding of concepts. The lowest aspect observed was evaluation/reflection skills (score <50) because some students could not reflect on their learning activities and test results. However, in Cycle II there were improvements so that the students became familiar with the stages of planning, checking, and evaluating the completion of assignments in students' worksheets and test questions.

Reflection activities encourage students to metacognitive through three stages: (1) remember exactly how to prepare for the exam, (2) make a detailed list of mistakes made during the exam and why they happened, and (3) plan better for the next exam (Lovett, 2013). Furthermore, students write reflective notes about conceptual understanding and the learning process so that students can practice metacognition, and feedback encourages students to become reflective learners.

Knowledge Learning Outcomes

The increase in students' meta-cognitive skills in each cycle (Table 1) was followed by an increase in the average learning outcomes and mastery of students' knowledge learning outcomes presented in Figure 2.

From a classical standpoint, completeness increased from 42.42% in cycle I to 78.78% in cycle II. This demonstrates that implementing the TBLDI model's tasks (Figure 3) facilitates students' meaningful learning processes, resulting in better learning outcomes for students' knowledge and metacognition abilities.

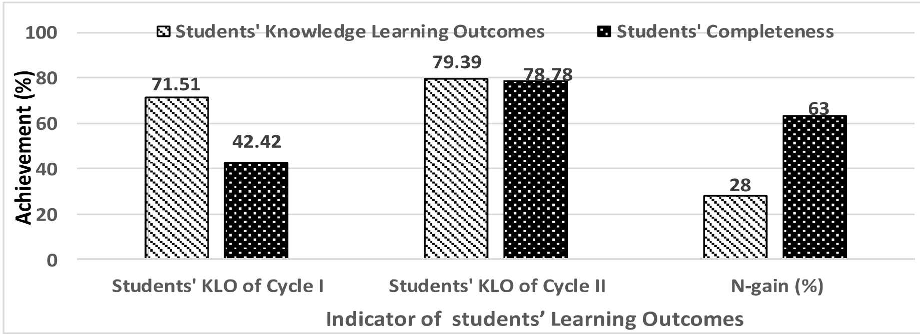

Figure 2 Percentage of Knowledge Learning Outcomes of Students Who Completed

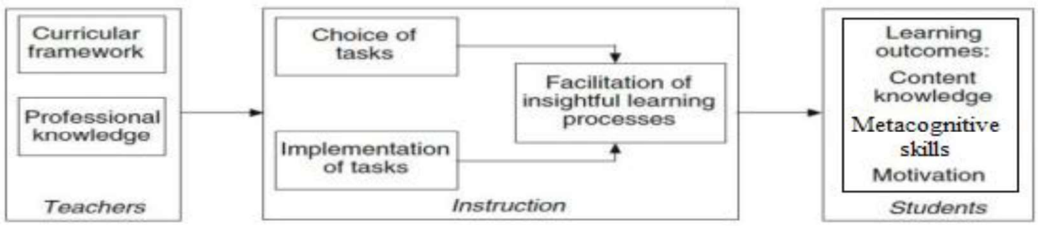

Figure 3 Tasks in the TBLDI model facilitated learning outcomes of metacognitive knowledge and skills adapted from (Baumert et al., 2013)

Learning Outcomes Attitudes and Skills

The attitudes of the students observed included curiosity, responsibility, and cooperation. The attitude of students as a whole increased from 7.98 (good) in cycle I to 9.03 (good) in cycle II. This means that the teaching and learning process using the TBLDI model can improve aspects of student attitudes. This suggests that the TBLDI model can improve student attitudes during the teaching and learning.

Overall student skills in cycle I and cycle II showed an increase, where the overall average skill of students in cycle I was 4.87 in the less skilled category while the average overall skill of students in cycle II was 6.54 in the skilled category. This is in line with research conducted by Nurmala et al. (2015) dan (Khotimah et al., 2017), which stated that applying TBL supplemented by worksheets and performance assessments based on contextual chemistry learning had succeeded in improving students' laboratory/practical skills very well.

TBLDI Model Feasibility

The results of observations of implementing the TBLDI model and student activities can be seen in Figure 4.

Based on the data, Figure 4 shows that the implementation of the TBLDI model learning has grown from cycle 1 of 33.22 to 35.44.

Cycle 2 has a very good category. This is due to the teacher improving class planning and teaching actions, including improvements when dividing groups, such as immediately giving marks or numbers on the group seats and the group leader noting the members' names again. Improvements were also made in assisting students in problem-solving; the teacher motivated student involvement by making students feel that all gestures of activity would be valued at that time. The teacher continues to be seen taking notes on the rubric for assessing the activities and skills of students, so initially, the students were less active; they changed to actively discussing and issuing opinions.

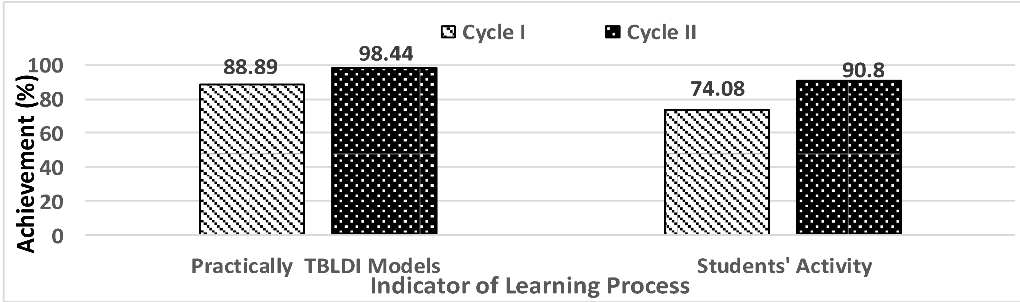

Figure 4 TBLDI Model Feasibility and Students' Activities

The average student activity score in cycle I was 26.67 and cycle II was 32.69 in the very active category. This increase is influenced by the increase in educator actions in each cycle. When facing difficulties, the teacher would always guide students so that interactions occur well. This increase also shows that the improvements in Cycle I can be applied to Cycle II properly.

Analysis of Learning Outcomes Knowledge and Metacognitive Skills

The TBLDI model of colloid learning can boost metacognitive skills. Their thinking processes improve when students in class XI IPA 3 SMA Negeri 10 Banjarmasin were assigned an action. Students in cycle II demonstrated an increase in metacognition. This is possible since students are accustomed to using the TBLDI paradigm in chemistry class. According to Ratri and Sugiato (2016) findings, using the DI model can improve students' metacognitive abilities.

One benefit of employing the TBLDI approach is that students can use metacognitive skills, conceptual knowledge, and problem-solving to meet the problems of 21st-century education. These results follow research findings stating that if students carry out a series of learning activities consciously involving metacognition in problem-solving tasks, they will improve their understanding of concepts and metacognitive skills (Hasanah & Mitarlis, 2016; Syahmani et al., 2020; Zepeda et al., 2015).

Problem-based colloid learning in the context of local wisdom, such as river water purification, can hone self-awareness and students' understanding of colloidal properties, for example, the effectiveness of alum in river water/peat water (black water) treatment for coagulation and the use of adsorbents in water, purification including colloid adsorption properties.

The achievement of knowledge learning outcomes is very important for students so that the material absorbed by students will be more meaningful; therefore, by using the TBLDI learning model, the teacher tries to fulfill students' goals in learning. The tasks play a fundamental role in improving the quality and efficiency of education: (i) practical and application tasks will increase independence and autonomy (Andersson-Bakken et al., 2020; Mezirow et al., 2019), (ii) diagnostic and evaluation tasks serve to address misconceptions (Neidorf et al., 2020) and to promote transparency in the expectations associated with evaluation (Hattie, 2012).

Tasks' Role in the TBLDI Model

To make it easier for students to understand colloidal material, the researchers work around this by assigning LKPD with TBLDI steps to students. This project attempts to have students indirectly read and grasp the content to be examined first for them to be able to create experiments.

Table 3 shows the results of learning assignments in cycles I and II. The average assignment score in cycle I was in the good category, but there were still three roles of students in the sufficient group. The increase occurred in cycle II the average score of the task was in the very good category and the role of students was no longer in the sufficient category.

The highest score in cycles I and II related to the role of students is in the role of the planner, where the results of the metacognitive skills test also score the highest on the metacognitive indicators of planning. This shows that students are getting used to the planning stage to solve problems because of the tasks given and done well, especially in the part of the planner's role. Assignment with TBLDI stages is a learning method that aims to build students' knowledge in systematic learning, namely to increase students' knowledge by mastering learning concepts and problem-solving knowledge.

Table 3 Category of cycle I and II task scores

No.	Students' Roles	Cycle I		Cycle II	
		Score	**Category**	**Score**	**Category**
1	Planner	100,00	Very Good	100,00	Very Good
2	Information Collector	100,00	Very Good	100,00	Very Good
3	Data Organizer	73,33	Good	93,33	Very Good
4	Schematic Designer	100,00	Very Good	100,00	Very Good
5	Trial Setup	73,33	Fair	80,00	Good
6	Presenter	60,00	Fair	80,00	Good
	Average Score	**84,44**	**Good**	**92,22**	**Very Good**

Results from previous studies (Costa, 2016; Espinosa et al., 2013; Zhao, 2005), showed that TBL is appropriate to apply in teaching instruction. TBL is also appropriate to use in learning chemistry (Qing et al., 2010; Zhou et al., 2013). The advantage is that students can directly choose the available resources to fulfill the task through assignments. TBL-based learning can bring out existing efforts in students and allow them to explore their own knowledge.

Most students are unaware of their metacognitive talents, which they employ to monitor and govern their cognitive processes. Metacognitive skills can encourage students to determine whether the actions taken in solving the problem were successful and make it possible for them to understand the concepts they are learning; thus, learning with the DI-TBL model can further improve students' metacognitive skills.

CONCLUSION

Students' metacognition skills in colloidal material improved from the starting to develop or developing category in cycle I to the well-developed category in cycle II. Students engage in a sequence of metacognition processes consciously at each stage of the TBLDI model, including planning, monitoring, and evaluating in problem-solving assignments.

In cycle II, overall knowledge learning outcomes have reached completeness standards, the attitudes are in the good category, and the skills are likewise in the skilled category. In cycle II, the implementation of the TBLDI model learning on colloidal material improved to a very good category. Student participation also increased to a highly active level when participating in learning on colloid material.

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