Practicality of Cognitive Style-Based Learning Strategy for Developing Science Problem Solving Ability of Elementary Students

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Abstract—This study is part of the research and development of cognitive style-based learning strategy for developing problem solving ability of elementary students. Practicality of the learning strategy, which is realistic usability to be applied in the learning process of conductor-insulator and material change, was investigated. It was measured by observation of learning process, and questionnaire/interview of both teachers and students. This research showed that the learning strategy is practice for developing the science problem solving ability of elementary students: experts and practitioners judge that that the strategy developed can be applied in the class with validation score is excellence category; the usability of learning strategy, relationship between it elements and it characteristics is excellence category, respectively. The students perform a good learning activity along the science class. Generally, teachers as well as students did not have obstacles, significantly in applying the learning strategy in elementary science class. Although, the field independent (FI) student tend to give more positive response than the field dependent (FD) one. This finding will lead to a supporting to the implementation of national science curriculum.

Keywords: learning strategy, science, cognitive style, field dependent, field independent, problem solving

I. INTRODUCTION

Problem solving is one of the 21st century skills that have to be practiced to the students since they are in the childhood in order to prepare their future. They may be organized into four group, each comprising three to four competencies [1]: thinking includes creativity, critical thinking, problem solving and metacognition; working involves communication and collaboration; information and technology literacies are the tools for working; citizenship, life skills, and personal responsibility are necessary for living in the world.

Problem solving requires a set of knowledge that must be possessed by the students as factual, conceptual and procedural knowledge [2]. Thus, the more relevant knowledge, the better their ability to solve the problems encountered. When students experience learning through the problem solving, students have more potential in creating the optional ways to solve the problem, developing new understanding, and increasing their ability to understand the problem in depth [3].

Childhood, especially 6-11 years old, is the important phase for developing students’ problem solving ability. Elementary students (6-11 years old) have the concrete operational stage of cognitive development [4]. According to [5] the elementary school students of Banjarmasin generally have the concrete reasoning ability and few of them have the transition reasoning ability and beginning of formal reasoning. Mean while, most of them have the field dependent cognitive style, although there is a significant number, 33% of field independent cognitive styles. In this stage, they are rooted deeply in their environment and have difficulty with abstract thinking. As expressed by [6], they able to construct a concepts to see a relationships and even to solve a problems, if they involve a real object or known situation.

In order to develope problem-solving ability of elementary school students, the problem-solving-based learning strategy must be able to accomodate cognitive development of students. At the concrete operational stage, student will be able to think logically if these thinking can be applied to authentic or concrete examples [7]. According to Nur (2011), students in this concrete operations stage can draw conclusions based on the concrete experience gained through their senses (empirical inductive reasoning). Learning should also provide a funny environment, e.g by implementing game which appropriate to students’ characteristics. It’s will lead students to well perform accommodation and assimilation of knowledge.

Other students characteristic that have to be consider for developing problem-solving ability is cognitive style. Cognitive development related to one's readiness and ability to perform a certain development
tasks including learning, while cognitive style refers to a person’s preferred way to process information. According to [9], "Cognitive styles refer to differences in people’s preferred way of processing (perceiving, organizing, and analyzing) information, using cognitive brain-based mechanisms and structures. Many research show that cognitive style affects the students learning outcomes (Sholahuddin et.al, 2014), as well as students ability in problem solving. Students with a field independent (FI) cognitive style shows many characteristics as analytical, individual and independent, while students with a field dependent (FD) cognitive style tend to be global, social and less independent in perceiving, remembering, thinking, and problem solving [11], [12]. Although there is a tendency that FI student achieve learning outcome better than FD student, both FI and FD can be successful in learning as long as it is used the appropriate strategy to their style [13].

Accommodation of cognitive styles in learning process, may lead to emergence self-motivation. In addition, by knowing the students’ cognitive style, teacher will be easier to design strategy that facilitate cognitive style differences and provide scaffolding, in order that learning takes place optimally. According to [14] scaffolding is considered as assistance from a more knowledgeable person (teacher or peer) that help learners to do a learning task beyond their capability. Dynamic scaffolding is a holistic, integrated, and synergic approach to support learners in accomplishing their learning goals through the just-in-time and proper integration of multiple resources (experts, peers, technologies, and learning context). Further, refer to any research they discribe that scaffolding tends to be effective when provided through verbal discourse, teacher modeling, and pedagogical tools, such as triggering student sense-making, task-problematization, visualization and representations of knowledge, and construction of arguments and explanation.

The guided problem-solving-based learning strategy appropriate to student’s cognitive development stage and consider the student’s cognitive styles, was designed with the steps of attention, understanding problem, exploring, sharing, games, assessment and individual task or be abbreviated as @UnESa-GAIIn learning strategy. It was valid according to experts rating [10] and need to field trial to evaluate it’s realistic usability in science learning.

The problem of this study is: Could the @UnESa-GAIIn learning strategy develops the science problems solving ability of elementary school students? How is the practicality of @UnESa-GAIIn learning strategy? Learning strategy is considered to be practical if it is easy to be applied by teachers and students and they have not obstacles, significantly in applying the learning strategy in elementary science class.

II. RESEARCH METHOD

This research applies the design research and development model of Dick & Carey [15]. This study is the step of field trial evaluation to evaluate practicality of the learning strategy for developing the science problem solving ability of elementary students. Field trial evaluation was conducted in two elementary schools of Banjarmasin, which are SDN Pasar Lama 1 and SDN Pasar Lama 2. Practicality of the learning strategy was observed and evaluate by using observation sheet of it applicability by teacher, observation sheet of student activity in in science class and questionnaire of teachers and students response to it application. Rating category of the elements of learning strategy practicality are 3.51 to 4.00 = excellence; 2.51 to 3.50 = good; 1.51 to 2.50 = moderate; and 1.00 to 1.50 = poor. In addition researcher also conducted a limited interview both to the teacher and students to clarify their response.

III. RESEARCH RESULT

Fig.1 shows that the components of learning strategy can be implemented very well by the teachers in learning science in elementary school. Mean while Fig.2 shows that among the components of learning strategy relate to each other very well. Generally, implementation of the learning strategy reflect the design as theoretically designed in accordance with cognitive style, reasoning development of elementary school students, and the balance of teachers and students roles (Fig.3).
Fig. 4 shows that the aspects of students’ learning activities of 2nd, 14th, 15th, and 16th have the lower scores than others. Even though, the average score of students’ learning activities is good category, which concide of: (1) students pay attention to the teacher’s explanation or guidance (2) students pay attention to other students’ explanations (3) students present their ideas or opinions in problems solving process (4) students ask questions to teachers or other students (5) student response to the questions from teachers or other students (6) students try to understand the problems was presented by teachers through the students worksheet (7) students make predictions of the problem answer (8) students seek information from various sources or conduct observation to solve the problem (9) students presents the observation data (10) students interpret or explain the data (11) students make conclusions of problem solving (12) students prepare and present the result of problem solving (13) students evaluate the obtained solution students follow the evaluation in accordance with the purpose of learning (16) students work individual tasks, seriously (17) students read the textbook used in the study (18) students use worksheet (19) student do not perform irrelevant behaviour (talking about an unrelated matter, leaving the class, calling to someone, not paying attention, daydreaming, etc.).
Fig. 5 and Fig. 6 demonstrate that both teachers and students did not have the significant problems in implementing this learning strategy. Teacher say that they can apply all the aspect of cognitive style-based learning strategy with response in excellence category.

IV. DISCUSSION

Usability of the learning strategy demonstrate that it can be applied in the learning process according to the purpose of the development [16]. The study showed that teachers are able to apply properly all of the components of strategy that includes learning stage, social system, principle of the reaction, the support system and the instructional and nurturant effect (Fig.1). In addition, teachers are also able to perform the relationship between components of strategy as described on Fig. 2. This is in line with the expert’s judgment where this strategy have the content as well as construct validity [10]. Teachers of both schools showed the similar
performance in implementing all the components of strategy. Based on the classroom observations, generally teachers require adaptations in early learning, especially in consideration to students’ cognitive styles. The cognitive style is a novelty concept for teachers, while the cognitive style is an importance characteristic of the strategy that determines how the principle of reaction will be applied in teaching. It relate to how teachers use different approaches to students with different cognitive styles as well as how teachers perceive and respond to what students do.

In general, the elementary school students of grade 6 were able to follow the steps and the process of learning by by applying problem-solving cognitive style-based learning strategy (Fig. 4). However, students need habituation of learning more independently. Based on this research, students activities which need to be improved continually includes: attention to explanations of other students, engaging in rehearsal games to deepen the concepts, following evaluation in accordance to the purpose of learning, and doing individual tasks seriously.

Elementary students tend to not accustomed to follow the student-centered learning strategy as well as interact to the others in group, and do not completing tasks independently, yet. Learning independence or self-regulated learning (SRL) is a process that assists students in managing their thoughts, behaviors, and emotions in order to successfully navigate their learning experiences. SRL concise of three steps: forethought and planning, performance monitoring, and reflections on performance [17]. During the forethought and planning phase, students analyze the learning task and set specific goals toward completing that task. Meanwhile, in the performance monitoring phase, students employ strategies to make progress on the learning task and monitor the effectiveness of those strategies as well as their motivation for continuing progress toward the goals of the task. In the final reflection on performance phase, students evaluate their performance on the learning task with respect to the effectiveness of the strategies that they chose. During this stage, students also must manage their emotions about the outcomes of the learning experience. These self-reifications then influence students future planning and goals, initiating the cycle to begin again. According to [18] and [19], self-regulated learners are resourcefulness and engagement, so they perform better on academic tests and measures of student performance and achievement. This SRL will continue to evolve along with the development and experiences of individuals including study habits.

Ability of 6th grade of elementary school students in cooperative activities and investigation skills are still very weak. They are not accustomed to following learning activities that involve cooperative work, discussions, and inquiry [10]. Students’ basic process skills such as observing, communicating and inferring is relatively poor, especially experimenting process skills [20] which is an advanced process skills. Thus process skills in one side is required in problem solving process, in the other hand they can be developed through problem solving-based learning activity. In this study, teachers have been provided scaffolding to the students gradually, in accordance with the students’ cognitive style. In the early learning teacher explain and demonstrate the task who students are expected to complete on their own, provide step-by-step instructions (by verbal statement or by writing in worksheet) to solve the problem, and encourage students to interact with a new problem or task in their group. Ref. [21] classified this types of scaffolding to conceptual scaffolding (helps students decide what to consider in learning and guide them to key concepts), procedural scaffolding (helps students use appropriate tools and resources effectively), strategic scaffolding (helps students find alternative strategies and methods to solve complex problems) and even metacognitive scaffolding (especially assists students reflecting on what they have learnt).

Students appear to have been progressing in the involvement and independent learning from the first meeting to the next. Teachers reduce their role in the learning gradually. Teachers start the learning by applying problem-solving using direct instruction strategy, but then gradually they balance their role in the learning through cognitive style-based problem solving strategy. The proper scaffolding or guidance moves students towards their learning goals. It is a method of moderating the cognitive load of a learner. So, they will reach the learning goals easier because they are in their zone of proximal development [22].

Some theoretical views suggest that rather than delaying a high level of guidance, providing it from the outset will optimize student learning. According to Cognitive Load Theory that working memory limitations dictate high levels of instructional guidance initially for domain novices, but that such guidance becomes redundant, and even dysfunctional, as learners acquire expertise. Ref. [23] report that a high degree of instructional guidance to the third grade children leads to shallow learning and transfer, the high followed by high (HH) group demonstrated a stronger understanding of control of variables strategy (CVS) than low followed by low (LL) group. Moreover, it was found that no advantage for preceding high guidance with low guidance. Novices benefit more from viewing detailed examples of solution steps, and as they gain domain expertise, they learn more from engaging in unstructured practice problems. Providing guides gradually also reported by [24] that the high school students were able to mastery on the chemistry concept and process skills properly, if the learning delivered from direct instruction to guided inquiry, but they can not follow the free inquiry learning strategy. Nevertheless based on questionnaires and interviews students to feel free and enjoy to
participate in free inquiry-based learning. Thus giving scaffolding gradually from the strong to the less guides have been made the students learning easier.

This study shows that the rehearsal game helps students to understand the concept more deeply as well as provide a more funny atmosphere variation. This stage is most preferred by students, but there is a tendency requires a long time to apply. Therefore, in this study the teachers had a little problem in controlling the time. Even, at one particular meeting they had not opportunity to do this activity, but combined to the next meeting. It is a disadvantage of this strategy, because we have to involves students in exploratory learning activities in relatively limit of time. Understanding of science concepts greatly affect a person's ability to solve science problems encountered.

According to [25] the main purpose of problem solving based learning is not to study a large number of new information, but rather to practice the problem solving investigating skills and how to be an independent student. Solving the problem requires the activity of knowledge constructing and rules that have been studied that can be applied to new situations. Solving the problem involves the formation of high-level rules or the more complex rules. The complex rules are formed by combination of rules and defined concepts. Rules and defined concept are formed through the combination of several concrete concepts and to mastery the concrete concepts students have to master the discrimination. When they find a particular combination of rules that fit the solution, they have not only solve the problem, but also have learned something new or high-order rule [26], [2]. This study is in line with [27] reports that the application of PBL for grade 4 elementary school children in North Carolina increase the student engagement, knowledge and skills to solve problems is higher than direct instruction, although the retention rate of students' knowledge is no different.

Both of the teachers and students expressed no obstacles in implementation of this teaching strategy, but they just need to adaptation gradually (Fig.5, 6a and 6b). Our preliminary study showed that learning strategy usually applied by teachers in the classroom is expository-based to mastery the content knowledge. Therefore, by applying this strategy both teachers and students must change their learning habit. In this research, learning begins with direct instruction strategy and futher reduce the role of the teacher in learning, gradually. FI students with cognitive styles tend to provide a more positive response in all aspects of learning than FD students. The students responded positively almost all the statements about implementation of learning strategy, but both of the FI and FD students’ response to the 14th statement e.i “I have no difficulty in following the way of learning this” lower than the others in both schools. Even, FI students at one of the schools responded just in moderate category. It shows that students still have a slightly difficulty in adaptation to this learning strategy. The strategy is relatively new for students in case of learning phase as well as learning tools that support. The form of problem solving worksheets, e.g was not known well by students on previous learning, yet. This fact suggest that the need to simplify learning tools or additional guidance when a community of students in a class are still have difficulties.

Based on the interviews, both FI and FD students like this learning strategy because they can apply the concepts directly through experiment. Students also consider that cooperative problem solving activity had been provided opportunity to brainstorm in understanding the science concepts. FI students ability to follow the lesson better than FD students. In learning process, FI students seemed take a role in exploration activities more than FD students. Although, this strategy seeks to strike a balance between activities that correspond to cognitive style both FI and FD.

Generally, the activity of problem solving requires a working systematically and analytically. So, it makes sense if students FI will tend to be more adaptable to this strategy. According to [28] that the FD/FI construct representing perceptual ability, but not extensive cognitive style. While, [29] found that effects of cognitive style on motor performance may be at the level of perception is not at the level of the motor. Perception is our sensory experience of the world around us and involves both the recognition of environmental stimuli and actions in response to these stimuli. Through the perceptual process, we gain information about properties and elements of the environment that are critical to our survival. Perception not only creates our experience of the world around us; it allows us to act within our environment. Perception includes the five senses; touch, sight, taste smell and taste. It also includes what is known as proprioception, a set of senses involving the ability to detect changes in body positions and movements. It also involves the cognitive processes required to process information, such as recognizing the face of a friend or detecting a familiar scent [30]. So the more better the perceptual ability, the more adaptable of the student to follow the learning strategy that involve problem solving activity.

This study reflect that the teachers are able to apply the strategy and actively involved in learning through providing the adequate scaffolding base on the students’ characteristics and abilities, so it can reduce the difficulties experienced by FD students. Teachers can apply the stages of learning strategy, and relationship between components of the strategy very well. In addition teachers also able to perform very well the general characteristics of strategy i.e problem solving, consider the development of students’ reasoning, cognitive style, knowledge construction, and cooperative process. In addition, students are able to follow the lesson well also, although FI students tend to respond more positively to the implementation of strategy than FD students.
Some factors that require attention for optimizing usability of learning strategies are: size of class or students’ group in learning, simplification of individual tasks, and control of instructional time. Generally, at elementary school of Indonesia the average number of students in a class is relatively large, 30-32, even at two schools in this study, each class consist of 33 and 39 students. If instruction will be designed in groups with members of four students, there will be a minimum of 8 groups. Consequently teachers will have difficulty to manage the cognitive style-based learning strategy. The fewer of class size or groups, thus teachers will be more easily to manage the classroom and provide learning guidance. At small groups try out, with two groups in one class of SD Muhammadiyah 8-10 Banjarmasin (Sholahuddin et al., 2015), showed that teacher more easily to manage the classroom and almost all the students can be encouraged to engage in the problem solving process. Even though, in particular the individual task is still relatively difficult for the students. This is caused by their level of independence have not been developed, yet. So in this strategy individual tasks more emphasis on the deepening of science concepts being studied in the form of answer the question provided in student book.

V. CONCLUSION

The cognitive style-based learning strategy was proved its practicality in science learning at elementary school. It mean that it can be apply by the teachers in science class to develop science problem solving ability of elementary students. Experts and practitioners have been judge that the learning strategy is valid with validation score is exelence category. The usability of learning strategy, relationship between it elements and it characteristics are exelence category, respectively. In addition, students perform a good learning activity along the science class. Teachers as well as students did not have obstacles, significantly in applying the learning strategy in elementary science class. Field independent student tend to give more positive response than the field dependent one. It is indicate differentiation of perceptual ability which them which lead to difference in processing information and ability to solve the problem.

REFERENCES


