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The effect of learning styles on the critical thinking skills in natural science learning of elementary school students

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Abstract. Elementary school students being concrete operational development have the opportunity to trigger the higher-order thinking processes, including critical thinking. The context of VARK learning styles refers to the elements of modalities that are classified into visual, auditory, read, and kinesthetic styles. This research was conducted to examine the effect of learning styles on critical thinking skills (CTS) of elementary school students in Ambon-Maluku. The instrument of CTS rubric was developed from the Delphi consensus. The results of this research showed that learning styles (LS) did not have any significant effect on CTS. The differences in how to receive and to process information in learning is not a determining factor of the development of CTS. This research recommends that teachers need to be specifically trained to teach CTS. Moreover, it is necessary to create a constructivist learning environment using learning strategies or learning models that could potentially develop the students' skills of interpretation, analysis, inference, evaluation, and explanation. Further research is required to examine the effect of learning strategies, age, and students' learning experience on the development of students' thinking skills.

Keywords: Critical thinking skills, elementary schools students, high order thinking, learning styles

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INTRODUCTION

Human life in the 21st century as the era of digital technology (Higgins, 2014) is filled with competitions in various aspects. People are required to evolve as technology develops, by having the relevant competence and qualifications in addressing various issues of life. The competition can be well passed if people have the communication skills (CS), critical thinking skills (CTS), and problem-solving skills (PSS) in different domains of life (Carlgren, 2013). The development of critical thinking skills is done to facilitate the transitions of students' knowledge and skills that are actualized as their responsibility and roles in society in the future. *International Society for Technology in Education* (ISTE) since 2007 has initiated the necessary skills in the digital era, namely creativity and innovation, communication and collaboration, research and information, critical thinking, problem-solving, decision making, digital citizenship, as well as technology operations and concepts (Larson & Miller, 2011).

Critical thinking is one aspect of higher-order thinking skills (HOTS) developed in constructivist-based learning (Cimer, Timucin, & Kokoc, 2013; Florea & Hurjui, 2015; Sendag & Odabasi, 2009). According to Gedik (2014), critical thinking has several elements such as focusing on problems, analyzing the discussions, proposing, challenging, and responding to questions, assessing the accuracy of the data and making conclusions, evaluating predictions, and communicating with others. Critical thinking is a central component of human intelligence and plays a role in the achievement of learning results (Klein, 2011). CTS is one element of the critical thinking construct (Yeh, 2009), which is seen as reflective and reasoned ways of thinking to decide what is trustworthy and can be done by someone (Fisher, 2001). Delphi consensus defines critical thinking skills as the skill of assessing our own mind on the results of interpretation, analysis, evaluation, inference, and explanation to make decisions that consider the concepts, methodologies, criteria, and contexts (Facione, 1990). Critical thinking skills serve as indicators of learning results and provide useful information for students, as well as to solve problems encountered in everyday life (Ernst & Monroe, 2004; Bailin, 2002).

The more comprehensive limitation of critical thinking skills put forward by Facione (2013) in the consensus presented various experts on the concept of critical thinking. In this consensus, critical thinking is seen as self-regulation in judging something that includes elements of interpretation, analysis, evaluation, and inference, as well as exposure using evidence, concept, methodology, criteria, or contextual consideration on which decisions are made. Interpretation is the skill to understand and express the meanings or meanings of various experiences, situations, data, events, judgments, conventions, beliefs, rules, procedures, or criteria. An analysis is a skill to identify inferential relationships between questions, statements, concepts, descriptions, or other forms to express beliefs, judgments, experiences, reasons, information, or opinions. Evaluation is a skill to assess the credibility of a statement or assess the quality of the argument put forward. The inference is the skill to identify or determine the elements needed to draw logical conclusions. Exploration is the skill to explain conclusively, state the results/procedures, and present arguments. Self-regulation is the self-awareness to assess one's own cognitive, beginning with the process of monitoring the self consciously.

Corebima (1999) stated that learning in Indonesia rarely or did not empower students' CTS at various educational levels. Learning appeared to be as a means to pursue graduation, so that the ultimate learning objectives were only to pass the graduation tests. Leasa & Matitaputty (2015) reported that the learning activities in Ambon had not focused on fostering students' CTS. It is characterized by the dominance of conventional learning or anonymous learning which centered on the teacher, and the teacher's knowledge and experience to teach CTS to the students have not been carried out. Such learning patterns fully give opportunities for the teachers to actively participate in the talking, thinking, and writing. Moreover, the interaction and communication between students and students, and between students and teachers are limited. As a result, the student's thinking is limited. Thus, the patterns of their CTS are not fully developed.

Ennis (1989) suggested that the best time to teach CTS to students was since they entered the elementary school level. According to Massa (2014), in the developmental stage of Piaget, children have not yet reached the stage of formal operations which are necessary for critical thinking. Vigotsky (1978) suggested that the development of children could be managed properly by adults and peers if the activity in the zone of proximal development (ZPD) was maximized and was supported by a good learning process. ZPD is the zone between the actual development level and the potential development level. The actual development level can be seen from the children's ability to complete assignments independently, while the potential development level can be seen when the children are able to complete assignments with the help of an adult (Aubrey, Ghent, & Kanira, 2012).

According to Colcott, Russell, & Skouteris (2009), as parts of cognitive processes, the development of students' critical thinking is influenced by social interactions with parents, peers, teachers, and students' characteristics. Students can learn maximally by using their learning styles. Learning styles can be seen as a consistent pattern of behavior and performance that students use in shaping learning experiences, because learning styles determine student learning processes. The foundations for our learning styles have been laid since childhood, and as a person matures, those learning styles tend to develop. The stronger the preference of a learning style, the longer it will change (Alaoutinen, Heikkinen, & Porras, 2012). Student perception factors, their relationships with others, cognitive structure, and physiological elements also influence learning styles. There is no good or bad learning style, but the most important thing is how students can arrange learning activities that are following student learning styles (Caliskan & Kilinc, 2012). If every individual can manage their learning in any condition, anywhere, anytime, then learning will be more effective and efficient so that the learning outcomes are more developed.

Until now, there are various learning styles models that have been developed. These models include the Kolb, Gregore, VARK, Fileder-Silverman, Dunn and Dunn models, and RASI (Hawk & Shah (2007; Cassidy, 2004). These learning styles developers view learning styles from different perspectives. Thus, Kolb's model, for example, places more emphasis on the process of receiving and processing various information from abstract to concrete, as well as the process

from active experimentation situations to reflecting reflective observations. On this basis, the Kolb model is grouped into diverger, assimilator, converger and accommodator learning styles (Heiland, 2019).

VARK stands for Visual, Auditory, Read, and Kinesthetic (Fleming & Mills, 1992) learning style models are based on the aspects of sensory modalities (Urval, Kamath, Ullal, A. Shenoy, & N. Shenoy, 2014; Liew, Sidhu, & Barua, 2015). Visual learners learn best by using pictures, charts, diagrams, hierarchies, and models. Auditory learners are happy to listen and discuss learning material; they showed more attention to the words spoken by the teacher. Read/write learners are pleased to read text material; they are happy to make sketches, paraphrasing, or underlining information read from written sources such as books and glossary. Kinesthetic learners easily internalize the information when they are doing physical activities/practices (Hawk & Shah, 2007; Dobson, 2009; Othman & Amiruddin, 2010; Pritishkumar & Michael, 2014).

The development of CTS is influenced by various factors, namely the learning environment, the social context of learning, and teachers' teaching styles (Brahler, Quitadamo, & Johnson, 2002; Shamir, Zion, & Levi 2008). Teacher's teaching style is also related to the student's learning style. Students have unique characteristics in managing information and storing the information in the memory system categorized by Roberts & Dyer (2005) as context variables. Thus, it can be predicted that the student's learning style has a correlation with their CTS. Several types of research have revealed the correlation between learning styles and CTS (Suliman, 2006; An & Yoo, 2008; Nosratinia & Soleimannejad, 2016). The unavailability of accurate information about the effects of learning styles of VARK models on the CTS of elementary school students encourages the importance of this research to be conducted. Based on this background, the writing of this article aims at revealing the information about the effect of the learning style of VARK models on the CTS of students, especially those of the elementary school students.

METHODS

Research Design

This was quasi-experimental research and 3 x 3 factorial design. The research was conducted to elementary students in Ambon-Indonesia on natural science subjects. The first variable was the learning model, consisting of the level of *Numbered Heads Together* (NHT) learning model combined with metacognitive strategies, NHT, and conventional learning. The second level was a learning style consisting of ARK (Auditory, Read, and Kinesthetic) learning styles. Visual learning styles were ignored in the design of this research because based on the results of the learning style tests conducted at sample schools, there were only 6 visual students. his is consistent with the findings of Leasa, Batlolona, Enriquez, & Kurnaz (2018) in the study of the determination of student learning styles in the city of Ambon, which in a sample of 769 students, visual students were only 5.98%. NHT is a type of cooperative learning model that emphasizes individual responsibility. The learning model has steps that can guide learning activities.

The NHT steps consist of numbering, questioning, heads together, and answering. In the numbering phase, the teacher divides students into groups of 3-5 people, and each person is given a number between 1 and 5. During questioning, the teacher asks questions to the group, so that each group member gets questions to be solved. In the heads together phase, each group member thinks of completing the task/question given. After that, all members of the group put their opinions together in the discussion and convinced all members of the answers. In the answering phase, the teacher calls students with a certain number at random to give answers to the whole students around. Students who agree or disagree with the answers raised can provide feedback (Leasa, 2017). In this study, NHT was combined with metacognitive strategies. The strategy was carried out by students in the form of making a summary of the material that students will learn and do at home. Its function is to record information and or to help reflection. Whatever information is learned can be summarized so that it is simple and easy to

record. Summarizing can be used as a stable external memory in a form that can be used later on (Boch & Piolat, 2005). Other activities included in this strategy are self-assessing aimed at assessing student activities before, during, and after learning (Shannon, 2008).

Population and Samples

The population in this study were all fifth-grade elementary school students in the city of Ambon, Maluku province. In Ambon City, there are 23 core schools spread across 3 districts namely Nusaniwe, Sirimau and Baguala. Core schools are schools selected among cluster members who act as the center of development at the cluster level and have complete infrastructure in institutions. The core school also has educational and teaching staff who support efforts to improve the quality of education. Cluster is the division of school groups in a sub-district regional education office under the supervision of the Task Force unit of Sub-District Education Office. In one cluster, there is usually one core school.

School samples were determined by random method, 3-4 schools were randomly taken as representatives in each district, so that 10 school samples were obtained. Class V students in each sample school generally only consisted of one study group with 20-30 students. Information obtained through filling out the VARK learning style questionnaire shows that the total number of students with a visual learning style was less than 10 students. Therefore, the visual learning style was ignored in this study. Based on the complete questionnaire results, it was found that as many as 210 grade V elementary school students were involved in this study. Thus, there were 3 levels of learning styles namely auditory (A), read (R), and kinesthetic (K) with the number of students per class ranging from 20-28 students in this study.

Research Procedure

The study was conducted after obtaining a permit from the Ambon City government, especially the local education office. Data collection in schools through the permit, which is shown to the headmaster, including the willingness of the teachers and students directly involved. The students' learning styles were identified by using a LS test supported by a LS questionnaire. The learning style test was given before the process of the quasi-experiment research carried out. Before the test, the instruction to fill out the test was explained. The natural science learning process was conducted over 26 meetings or approximately 4 months, where the researchers also observed the consistency of students' learning styles, as well as made sure that the test results were relevant to the students' LS. These LS were demonstrated in real life based on direct observations and interviews with the students. Observations and interviews related to student learning styles during the learning process with the NHT model, NHT combined with metacognitive strategy, and conventional learning were carried out to ensure the consistency of student learning styles. The results of observations and interviews indicate that the student's learning style was still stable or the same as the results of the previous learning style test. The process was carried out, because there was a tendency that environmental factors including the teacher's teaching style affect student learning styles (Leasa, Corebima, Ibrohim, & Suwono, 2017), but the student learning styles tend to be the same or not change in the time of the science learning process for 4 months. If a student's learning style changes from before, then the student sample was not used or ignored.

The results of the LS test were corrected by referring to the provided answer key. Each statement item had four possible answers (V, A, R and K), so that the corrected results of the 16 statement items showed the students' responses to each question and the total scoring for each LS option. For example: if a student had scoring results as V = 2, A = 4, R = 2, and K = 8, so the student had K LS. On the other hand if the student got the scoring results as V = 3, A = 5, R = 3, and K = 5, so he or she had bimodal (AK) LS. On that basis, it was concluded that each student had a specific LS. In this research, the bimodal and multimodal LS were ignored because of the small percentage.

Research Instruments

The research instruments used were: VARK-LS questionnaire and CTS test. The learning style questionnaire used was a learning style questionnaire of young category version 7 developed by Fleming (2001) (www.vark.learn). The questionnaire was translated and adapted to the characteristics of high-grade elementary school students in Indonesia, especially in Moluccas. The instrument of CTS test was developed by the researcher referring to the core aspects of CTS by Facione & Facione (1990), which consisted of interpretation, analysis, inference, explanation, and evaluation. The instrument had been validated covering construct validation and empirical try-out. The CTS test consisted of 12 items in the form of essay questions, with the validity value 0.75 and reliability value 0.93. The allocated time to fill out each of the instruments ranged between 40-60 minutes. The CTS tests were conducted for 2 times, before the treatment (pretest) and after the treatment (posttest).

Data analysis

The data of LS were used to classify the students into the treatment groups based on the learning styles and analyzed descriptively. The effect of VARK-LS on CTS was analyzed by using covariate analysis using SPSS 18.00 for windows.

RESULTS

The data description of the pretest-posttest of students' CTS in terms of learning styles and learning model aspects is presented in Table 1.

Table 1. *Description of pretest-posttest of students' CTS based on LS and learning models*

Learning Model	N	LS	Pretest		Posttest	
			Mean	Std. Deviation	Mean	Std. Deviation
Conventional	25	Kinesthetic	20.56	9.31	28.33	10.07
	25	Auditory	23.09	9.86	29.84	12.35
	23	Read	24.56	11.52	29.54	13.10
	73	Total	22.69	10.22	29.23	11.73
NHT	24	Kinesthetic	26.32	10.13	60.67	14.32
	20	Auditory	22.36	7.44	53.78	9.23
	23	Read	21.93	9.56	58.07	10.61
	67	Total	23.63	9.29	57.72	11.89
NHT + Metacognitive	24	Kinesthetic	26.08	8.91	69.71	9.17
	21	Auditory	21.84	7.08	68.85	13.47
	25	Read	26.76	8.49	67.01	11.05
	70	Total	25.05	8.40	68.49	11.16
Total	73	Kinesthetic	24.27	9.71	52.57	21.21
	66	Auditory	22.47	8.23	49.51	20.30
	71	Read	24.48	9.95	51.98	19.73
	210	Total	23.77	9.35	51.40	20.38

Table 1 shows that the pretest mean for kinesthetic learning style ranges from 20.56 to 26.32, the auditory learning style ranges from 21.84 to 23.09, read learning style ranges from 21.93 to 26.76; the posttest mean of the kinesthetic, auditory, and read learning styles range between 28.33 - 69.71; 29.84 - 68.85; and 29.54 - 67.01 respectively. The results of the covariance analysis test related to the effect of LS on CTS are shown in Table 2.

Table 2. *Results of the covariance analysis*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	64448.802[a]	9	7160.978	64.018	.000
Intercept	41309.177	1	41309.177	369.297	.000
XB Critical Thinking	4806.352	1	4806.352	42.968	.000
Learning Model	55214.047	2	27607.024	246.802	.000
Learning Style	78.768	2	39.384	.352	.704
Learning Model * Learning Style	481.051	4	120.263	1.075	.370
Error	22371.819[a]	200	111.859		
Total	641765.870	210			
Corrected Total	86820.622	209			

a. R Squared = ,745 (Adjusted R Squared = ,733)

Table 2 shows the results of ANCOVA, where the value of F for learning styles is 0.352, and the significance value is 0.704 which means the significance value is greater than α (0.05). If the significance value is greater than α, then the null hypothesis is accepted. Conversely, if the significance value is smaller than α, it means the alternative hypothesis is accepted. Thus, based on the ANCOVA results, it is concluded that the null hypothesis is accepted. It means that the learning style has no significant effect on students' critical thinking skills.

DISCUSSION and CONCLUSIONS

Critical thinking is part of a person's intelligence. Research results show that LS does not have any effect on CTS. As already known, the LS of a person is different from that of the others, based on the best sensory modalities to receive, store, and process new information. The dominant sensory modalities have a significant effect on the sensitivity of sensory cues (Mahdjoubi & Akplotsyi, 2012). In the auditory learning style, learners like the information which are heard or spoken, such as, through discussion and dialogue. Read learners like the information through written material that they read, for example, from books, magazines, or written on the screen of TV. Kinesthetic learners receive information from their surrounding environment, by touching, tasting, smelling, and physical movement such as moving and doing activities. Thus, the VARK learning styles is solely oriented on the process of information receipt by using senses, in which each sensory modality has its own path. Sense as sensory modality becomes the main window where any information enter, thus it is known as sensory memory. Salmela, Moisala, & Alho (2014) asserted that visual and audio sensory places in different locations in the human memory system. In the next phase, the processed information is stored in short-term and long term memory.

In previous studies Ann & Soo (2008) obtained information that the level of critical thinking was found to be different in the learning styles of the KOLB model. This means that learning styles affect critical thinking. If the highest critical thinking score is found in the learning style of Converger, then followed by Assimilator, Accommodator, and Diverger. It was also concluded that critical thinking has a weak relationship with learning styles (r = 0.219). Furthermore, Nosratinia & Soleimannejad (2016) research found a significant and positive correlation between critical thinking and perceptual learning styles. This learning style consists of visual, auditory, tactile, individual, and group learning styles. This learning style tends to be consistent at the student level. Nevertheless, learning styles have not been a determining factor in critical thinking or vice versa.

The previous researches also supported the results of this research. Myers & Dyer (2006) reported that there was not any difference in students' CTS based on the learning styles. Their findings support the previous research by Rudd, Bakker, & Hoover (2000) that also stated that there was not any difference in the critical thinking of the student having field independent learning style and field-dependent learning style. Thus, the learning style factors can be ignored in developing critical thinking skills. Field independent and field-dependent learning styles are

learning style models developed by Witkin based on the habits of individuals in completing perceptual tasks (Cassidy, 2004). This learning style is related to the intellectual habits of a person, so that it is better known as cognitive style (Wooldridge & Bartolf, 2006). The students having field independent learning style can learn anywhere under any circumstances, without being distracted by the surrounding situation, while the students having field-dependent learning style require a situation that supports and does not interfere in the learning process. On the other hand, the VARK learning styles are based on the aspects of sensory modalities. In the context of learning, the supporters of modality preferences assume that individuals have a dominant sense of VARK learning style. The presentation of the learning material using the selected modality should be maximized (Lodge, Hansen, & Cottrell, 2015).

Arguments that can be put forward to explain that learning styles do not affect critical thinking skills include student awareness about learning styles is initial knowledge, and the immaturity of the cognitive processes that occur in learning. Regarding initial knowledge, the concept of learning styles shows that each individual has a different way of receiving learning instructions (Pashler et al, 2009). Students learn more efficiently if the teaching material and methods fit their learning styles (Chang, 2005; Ma & Oxford, 2014). An understanding of the differences in individual learning styles refers to the awareness of the learning styles that students have for the benefit of learning (Evans & Waring, 2009). Weak students' awareness of the learning styles that exist in them, resulting in not all students strengthen the cognitive process with the learning styles that are there.

The teacher's role is to remind elementary students to learn according to their characteristics. The main learning challenge is how students can learn well by exploring their learning styles? For students who are used to being independent and have high academic ability, this is not difficult. In fact the difficulty is usually experienced by students who feel weak and limited. Students become shy in exploring various information in accordance with their learning style, so in thinking too often imitating group friends. Therefore, efforts to build awareness of students about their potential, including the potential of their learning styles, need to be done continuously. According to Sadler-Smith (2001), the potential for such awareness allows students to see and question the behavior of their old habits. Students can be taught to monitor the selection and use of learning styles. In fact, most students are not aware of their learning styles and if left alone they may not begin to learn in new ways (Merrill, 2000).

Some contrast opinions with the above arguments, as stated by Tores & Cano (1995) that learning styles can be used to predict the achievement of CTS. Teachers need to organize an educational environment, so that it is conducive to promote actions that contribute to critical thinking skills. This does not mean that teachers need to change students' preferences in learning, but teachers need to use students' learning styles in planning and implementing the learning process. Suliman (2006) stated that KOLB learning styles affected students' CTS. KOLB learning style models are based on the way to process new information, including the strategies routinely used in learning (Wessel & Williams, 2004). This learning style has four poles that describe the tendency of a person in the learning process that affects the learning characteristics. The findings reveal that the students of the acceleration program with diverger learning styles have more significant critical thinking than those of conventional programs with a converger learning style. The students' demographic characteristic factors are the trigger of the difference in CTS in that case. The demographic characteristics are related to the levels of experience and age. As already known, the students of the acceleration program consisted of the students who already had more working experience than those of the conventional program. Viewed from the age factor, the students of the acceleration class were older than those in the conventional program whose inputs were from senior high school graduates.

The different experiences and age factors became the determining factor of CTS. In this research, the experience and age of the students having different learning styles (auditory, read, and kinesthetic) were homogeneous. The samples of the research were elementary school students in class V with the age range of 10-11 years old. Related to Piaget's developmental stage, the students in the concrete operational stage. The characteristics of the cognitive development of students, such as we're able to think logically, understand the concept of a

conversation, organize objects into classification, remember, understand, and solve concrete problems, as well as happy to try and to carry out experiment because they had a great curiosity. Brophy & Alleman (2009) stated that the elementary school students generally did not have a lot of experience, and still had limited knowledge of a particular topic. The experience and knowledge were not well organized or expressed verbally, and unconsciously. Therefore, the elementary school teachers need to be frequently confronted with the task of helping students develop and begin to integrate their prior knowledge which is very required.

In relation to the fact that the learning styles did not have any effect on students' CTS, the teachers do not need to focus on accommodating the differences of students' learning styles. Students can learn by using any preferences favored and comforting them in learning. Reading, writing, listening, and doing the physical activity are the students' ways of receiving information during learning. It also means that there are some other factors that are more instrumental in empowering CTS. The maximum learning process supported by various factors including the readiness of both teachers and students is important in developing students' CTS. Such processes need to be supported by a clear vision of learning, that learning is an effort to develop a construct of thought and knowledge, as well as skills to survive in the future. Learning does not end and does not have any objectives if the learners only aim to graduate or to get a certificate. The changes in learning vision and the purpose of teaching have become the key to the formation of commitment and the seriousness of the students and teachers to empower CTS. Such changes require special attention, energy, and time, as well as the training continuously (Saavedra & Opfer, 2012).

The results of this research prove that learning styles do not have an effect on students' CTS. It implies that there are other factors in learning that contribute to the development of CTS, and one of those factors is the learning model. Several types of research have reported that cooperative learning models were proven to increase students' CTS, such as *Snowballing,* NHT, *Cooperative Script,* STAD, TGT, the combination between STAD + TGT, *Cooperative Script* + TPS, and *Cooperative Script* + STAD (Maasawet, 2009; Warouw, 2009; Hasan 2012; Boleng, 2014; Talakua, 2015). In cooperative learning, the students' CTS are empowered in relation to the syntax of group work and discussion activities. During the group work, the students have more opportunities to speak, listen, and collaborate. In the discussion, there is an exchange of ideas, knowledge, or information (Slavin, 2015). These activities and social interaction encourage the development of higher-order thinking (Vandenburg, 2006). Students are organized in pairs or in groups, as well as interact with one another in an effort to complete the group tasks. When giving explanations, students construct their own knowledge, when they are explaining to their friends, they are transferring critical thinking to clarify their own knowledge related to a concept being learned.

In addition to cooperative learning models, problem-based learning (PBL) and inquiry-based learning are reported having the potential to improve students' CTS (Jufri, 2007; Madhuri, Kantamreddi, & Goteti, 2012; Gholami et al., 2016). Kek & Huijser (2011) stated that PBL consisted of several steps that could enhance students' CTS. At the stage of the problem presentation, students will first face or accept problems as a trigger of learning. They identify the facts, explore ideas and hypotheses, identify problems, and decide the actions to resolve the problems. Students also construct a plan of action to search, evaluate, synthesize, and apply the information required in solving the problems. Furthermore, at the stage of group investigation, students conduct an independent learning process and implement the learning in the context of groups. During this process, the students learn to critically evaluate the knowledge they need. At the stage of analyzing and evaluating the problem-solving process, students review various sources of information and solutions that are used, based on the latest knowledge and information obtained. At this stage, the students also do a reflection, so that new knowledge they obtain can help them to solve other problems they may face in the future.

In line with problem-based learning and cooperative learning which are based on the theory of constructivism, inquiry-based learning is done in a cycle to create meaningful learning. Friedman et al., (2010) mentioned that this learning model consisted of 5 stages, namely: asking, investigating, creating, discussing, and reflecting. CTS can be developed when the

students conduct an investigation. The investigation is generated through discussion with peers or in classroom discussions on the topics being discussed. During that period, the students propose hypotheses or specific questions to explore, conduct discussions to investigate the questions raised, and reevaluate the process of investigation that has been done. This model promotes self-reliance and creativity in problem-solving and the ability to transfer critical thinking to a complex and authentic problem.

The research results of Nurmaliah (2009) describe the other factors that also have an effect on the students' CTS namely the schools, gender, and prior knowledge. The research which was conducted at the junior high school students revealed that the CTS of the students in the high school category were significantly different from those of the students in the medium school category, and low school category as much as 8% and 21% respectively. This means that there is a significant difference in the CTS among the students of junior high school with high, medium, and low categories. In relation to the factors of gender, it was found that female students had higher critical thinking skills than those of the male students. Similarly, the students of high prior knowledge had higher critical thinking skills than those having low prior knowledge. This is in line with Corebima (2010) stating that students who had high prior knowledge are generally able to do reasoning, test hypotheses, and data analysis.

Based on the results of research and discussion, it can be concluded that: There is not any difference in students' CTS viewed from the VARK model learning styles. Student's learning style is one of the internal factors which are dynamic, so the teachers do not need to prioritize the management of students' learning styles in the teaching and learning process in the classroom. Teachers need to be prepared with the learning strategies or learning models that are potential in teaching and developing CTS.

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