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Enhancement of students' critical thinking ability in the algebraic function derivatives application based on student learning styles during online learning

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Abstract

Critical Thinking (CT) ability is an essential skill needed in the 21st century. However, this skill is still under-explored by paying attention to the tendency of Learning Styles (LS) students when online learning is carried out. Therefore, this study aims to determine the differences in the improvement of students' CT abilities based on LS tendencies (visual, auditory, and kinesthetic) when online learning is carried out on algebraic function derivative application materials. Consisting of 4 essay questions given twice, before the sample in this study was a collection of CT, and LS ability scores of class XI science students in Langsa City, totaling 26 students. The researchers collected the data using a LS questionnaire of 30 statements and a written test of CT ability after online learning. Both instruments have been validated. The research method is a pre-experimental design with the type of one-group pretest-posttest. The results showed that (1) students had more dominant kinesthetic LS tendencies compared to visual and auditory LS; (2) students with visual LS have criteria for increasing critical thinking skills in the high category, while auditory and kinesthetic LS is in the medium category; (3) there is a significant difference in the acquisition of CT abilities between visual, auditory, and kinesthetic LS, where students with Visual LS outperform students with Auditory and kinesthetic LS; (4) there are differences in the improvement of CT abilities between students with visual, auditory, and kinesthetic styles in online learning. The improvement in CT ability of students with visual LS is greater than that of Auditory and kinesthetic LS.

INTRODUCTION

Critical Thinking (CT) Ability is one of the focuses of 21st-century learning (Basri et al., 2019; Changwong et al., 2018; Marzuki, 2021; Nugraha & Suparman, 2021). CT skills are very important for students because it has the potential to help them to solve problems when in difficult situations. It also helps students communicate effectively and accurately (Marzuki et al., 2020; Kurniati et al., 2015; Pahrudin et al., 2021). In Indonesia's learning context, CT ability is one of the learning objectives, especially in mathematics. These objectives can be seen from the vision of Indonesian education in realizing an advanced Indonesia that is sovereign, independent, and has personality through the creation of a Pancasila profile that is critically reasoned, creative, independent, have faith, fears God the Almighty, and has a noble character, works together, and global diversity (Kemendikbud RI, 2021). To realize the creation of a Pancasila student profile, educators should familiarize students with developing CT abilities in the daily learning process.

Dewey (1910) defines CT ability as persistent judgment, persistent belief in persistence, and thoroughness in solving problems. This definition explains that CT ability is a person's way of not immediately accepting something or knowled ge for granted but trying to find reasons or

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supporting evidence first in solving problems. Glaser (1941) defines ability as an attitude that tends to be considered by someone in solving problems, especially in conducting investigations into the problems at hand. On the other hand, Ennis (1991) defines CT abilities as reasonable reflective thinking that focuses on deciding what to believe or do. A similar definition is also stated by Halpern (2014), which states that critical thinking refers to using cognitive skills or strategies that increase the likelihood of the desired outcome. According to Fisher (2001), children cannot be taught to think but must engage in intellectual debate. In other words, he claims that children can be taught to philosophize, improving their thinking, learning, and language skills (Fisher, 2001).

The results of research conducted by (Ennis, 1991; Facione, 1990; Fisher, 2001; Halpern, 2014) have tried to define CT abilities with various characteristics, such as disposition and critical thinking skills. Each researcher considers these aspects separately and describes them independently. However, the aspect of CT ability explored in this study is the result of hypothetical conjecture or interference in previous studies by Marzuki et al. (2021), which suggests that students' CT ability in algebra function derivative application materials can be explored through 4 components of CT ability. Therefore, in this study, researchers wanted to explore more about the four components of CT capability, which include: (1) reconstruction ability, (2) identification ability, (3) ability to explore, and (4) the ability to clarify (See Figure 1).

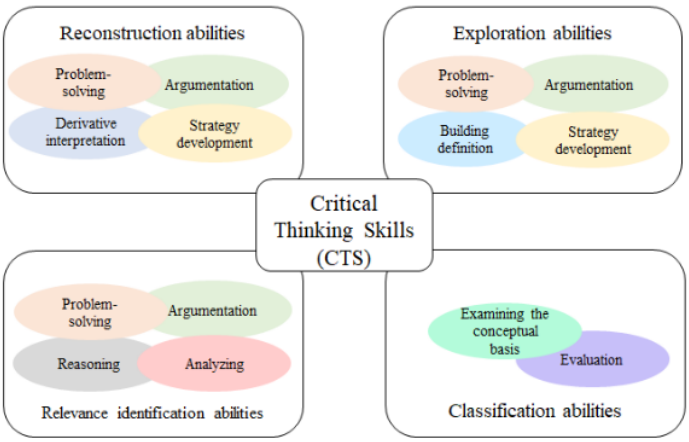

Figure 1. Indicators of Mathematical CT Ability (Marzuki, 2021)

From Figure 1, it can be explained that reconstruction ability is the ability to state a problem or argument in another form with the same meaning, or learners can develop alternative strategies in solving problems; Relevance identification ability is the ability to write down concepts contained in a given statement, and write down parts of statements that describe the concept in question; the ability to explore is the ability to study a problem from various points of view, formulate into mathematical models and build the meaning of mathematical models; and clarifying ability is the ability to evaluate an algorithm and examine the basis of the concept used in solving the problem.

In addition to improving students' CT ability in learning, other factors need to be considered in managing to learn, one of which is the student's mathematical learning style (Setiana & Purwoko, 2020). Learning style (LS) is a strategy that learners use in different learning contexts

(Chiou et al., 2017), Besides, (Bostrom et al., 1993; Chiou et al., 2017; Marzuki et al., 2019) Find that individuals with varied LS will produce unequal learning achievements. Further, Shaw, (2012) asserts that learning is most effective when learning strategies are based on the student's LS. Lehmann & Ifenthaler, (2012) LS is a typical learning method for students. This distinctive way is individualized, which is often not realized by students who, once formed, will tend to last for a long time and affect the learner's ability to understand and absorb lessons (Setiana & Purwoko, 2020).

Among the many diverse tendencies of LS, LS can be grouped into three: visual, auditory, and kinesthetic (Chrisley, 1995; De Porter, 2010; Setiana & Purwoko, 2020). Students with visual type LS are more likely to remember information by witnessing firsthand the source of that information (De Porter, 2010). Students with visual LS tend to remember information by looking at everything, such as instructions, computers, books, art, and the person they are talking to (Russel, 2012). Students with a visual learning style will quickly learn the materials presented in writing, charts, graphs, and pictures (Ahmadi, A., & Supriyono, 2013). As for the characteristics of a person with visual LS, among them are neat and organized in planning things, meticulous to the details, easier to remember what is seen than heard, quick readers, and prefer to read rather than be read (De Porter, 2010). During online learning, students and teachers have tremendous pressures in learning in terms of technology. Teaching methods, as well as mastery of the material delivered in online learning, where the concerns felt by teachers are the loss of social interaction that will lead to a decrease in the effectiveness of their teaching (Flack et al., 2020; Kalogeropoulos et al., 2021).

Research conducted by Kalogeropoulos et al. (2021) explained that most students showed positive engagement with the distance learning experience, even though the opportunity to learn mathematics with their peers was considered less. Meanwhile, research conducted by Setiana & Purwoko (2020) which focuses on studying LS-based CT abilities, reveals that the three LS have strong potential to develop mathematical critical thinking skills through stimulation from teachers. Based on the results of this study, researchers have not found any research that examines the ability of CT and LS in online learning. The uniqueness and novelty of this research area in the CT ability based on LS (visual, auditorial, and kinesthetic) in online learning by paying attention to nine aspects of student CT ability. Based on the description, this study aims to find out the difference in improving CT skills based on students' LS during online learning on algebra function derivative application materials. At the same time, this research question includes abilities including problem-solving, arguing, interpreting derivatives, developing strategy, reasoning, analyzing, building meaning, understanding basic concepts, and evaluating. This research is expected to provide new knowledge for teachers in preparing an ideal online learning model for developing students' CT abilities.

1. What are the characteristics of students' LS before online learning is carried out?
2. What are the criteria for improving the CT ability of students who tend to LS (visual, auditory, and kinesthetic) in online learning?
3. Is there a difference in CT proficiency acquisition between students with LS (auditory, visual, and kinesthetic) in online learning?
4. Is there a difference in CT proficiency improvement between students' LS (visual, auditory, and kinesthetic) in online learning?

The results of the study are expected to provide information as an inspiring preliminary study for teachers in developing students' CT skills by paying attention to students' LS (visual, auditory, and kinesthetic) in online learning.

METHODS

Design

Referring to the purpose and research questions, the research method used is pre-experimental research with one group pretest-posttest research design (Borg, 2014; Fraenkel, 2013; Louis Cohen et al., 2007), as seen in Table 1.

Table 1. One Group Pretest-Posttest Research Design

Pretest	Treatment	Posttest
0_1	$\mathcal{X}$	0_2

Information:

0_1: Pretest before being given the treatment of students' mathematical CT abilities

$\mathcal{X}$: Online learning using Google Meet

0_1: Postes after being given the treatment of students' mathematical CT abilities

Participants

The sample in this study was a collection of students' mathematical CT ability scores and the scores of students' LS tendency questionnaires in online learning at one of the high schools, class XI Langsa city, with a total of 26 students (14 male students, and 12 female students). Sampling techniques are carried out by purposive sampling.

Instruments

Instruments used in this study include the LS questionnaire and the written test of students' CT ability on materials derived from algebraic functions.

1. LS questionnaire test instrument

The LS questionnaire test instrument used in this study aims to group students based on the type of learning style tendencies, namely visual, auditorial, and kinesthetic learning styles. The questions are arranged by paying attention to the grid of learning style questionnaires (see Table 2).

Table 2. Students' LS Tendency Test Questionnaires before Online Learning

LS Tendencies	Indicators
LS visual	1. Neat and orderly. 2. Research. 3. A good long-term planner and regulator. 4. Remembering with visual associations. 5. It is easier to remember what is seen than heard. 6. Have trouble remembering verbal instructions.
LS auditory	1. Easily distracted by the commotion. It is easier to understand and remember what is heard than seen. 2. Difficulty remembering visual material. 3. Fluent speaker. 4. It's good to read books out loud.
Kinesthetic LS	1. Learn through manipulation and practice. 2. Lots of movement. 3. Use a lot of body language.

	4. Always physically oriented. 5. Want to do everything. 6. Like busy activities or games (physically).

LS trend questionnaire questions, arranged by adjusting to the application material derived algebraic functions as many as 30 items of questions. For more details (see Table 3), sample items of LS questionnaire test questions before online learning on algebra function derivative application materials.

Table 3. LS Questionnaire Statement

No	Statement	Yes or No
1	I take time to learn algebra function derivative application materials at home.	
2	I can't stand still for a long time while studying algebra function derivative application materials during online learning.	
3	Even though the internet connection was broken, and the class was noisy when learning online, I could still learn.	
4	I read the material on the laptop during online learning in my heart, not in a loud voice.	
5	I like to learn by practicing directly, not through online learning.	
6	I easily recognize my friend's voice when a presentation occurs in the network.	

2. Student CT Ability Written Test Instrument.

The second instrument is a test of students' mathematical CT ability given after the online learning process as many as four questions in the application material derived from algebraic functions (See Table 4).

Table 4. Student CT Ability Test Instrument

CT capability aspects	CT capability indicator	Question
Ability to reconstruct	Students can solve problems. Students can perform derivative interpretations. Students can give arguments and; Students can develop a settlement strategy.	1
Ability to identify	Students can solve problems. Students can perform reasoning. Students can give arguments and; Students can analyze.	2
Ability to explore	Students can solve problems. Students can develop a settlement strategy. Students can give arguments and; Students can build meaning.	3
Ability to clarify	Students can examine the basic concepts and; Students can evaluate the problem-solving process.	4

Validation and reliability of the instrument were carried out to ensure that the data obtained were valid and reliable. The validation procedures on both instruments are content validation and empirical validity. Content validation is in the form of confirmation to experts about the instruments prepared. For the instrument, the CT ability researcher involved two experts, namely a teacher in the field of mathematics studies and a mathematics education lecturer. At the same

time, the LS questionnaire instrument involved two counseling guidance teachers. The results of the content validation test showed that both instruments were content valid.

The results of the empirical validity test on the CT ability test instrument obtained $r_{count} = 0.891 > r_{critical} = 0.413$, so it can be concluded that the instrument developed is valid and can be used to collect research data. At the same time, the empirical test for LS questionnaire analysis obtained r_count for each question item in the questionnaire greater than 0.39. Thus, it can be concluded that all question items in the LS questionnaire are valid. For the reliability test of the CT capability test and the LS instrument test using Cronbach's alpha with a reliability coefficient of 0.672 and 0.892, both instruments have medium and high-reliability categories.

Research procedure

Researchers begin by determining the research issues that are important to research. Furthermore, the researcher determines the purpose of the study as a reference for the study. After obtaining permission, the researcher selects the research participants. Identifying learning styles and pretest giving are carried out before the lesson is delivered. After the online learning is completed, a post-test is conducted to see the improvement. The flow of the study can be described as follows.

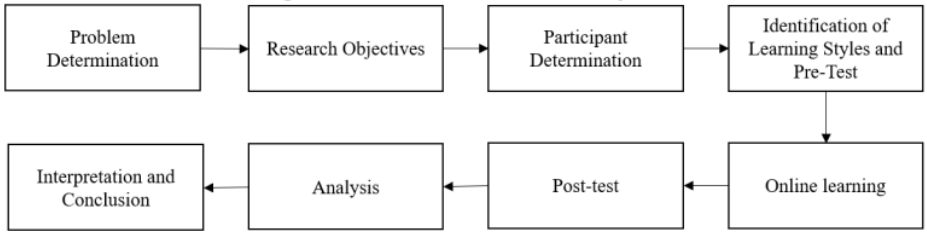

Figure 2. The Flow of Research

Data Analysis.

Student CT acquisition data is based on Post-test data, while improving data is based on N-gain scores (Hake, 1998). Furthermore, the data analysis used includes descriptive and inferential statistics to answer the research questions asked. Criteria for improving students' CT ability with student visual, auditory, and kinesthetic learning styles as shown in the formula below:

$$Normalized\ Gain\ Ternormalisasi\ (g) = \frac{Skor\ Postes - Skor\ Pretes}{Skor\ Maksimal\ Ideal - Skor\ Pretes}$$

For normalized N-Gain score criteria (See Table 5).

Table 5. Normalized Gain Score Criteria

Normalized Gain Score (g)	Interpretation
$g > 0{,}70$	High
$0{,}30 \leq g \leq 0{,}70$	Medium
$g < 0{,}30$	Low

Descriptive statistical analysis in this study was used to answer the first research questions. The second is (a) the student's LS tendency questionnaire (visual, auditory, and kinesthetic) before online learning is conducted, (b) to find out how the criteria for improving the student's CT ability whose learning style (visual, auditory, and kinesthetic), is analyzed using: mean, standard deviation, and Skewness using the help of SPSS-26.

Inferential statistical analysis is used to answer the third and fourth research questions, using the one-way ANOVA test (See Table 6), with the help of SPSS-26, then to answer the research

questions points (c) and (d), i.e., Whether there are differences in acquisition. The improvement of CT ability among students whose auditory, visual, and kinesthetic learning styles in online learning conducted advanced (post hoc) tests using the Tukey test.

Table 6. Mathematical CT Ability Acquisition Score Based on Student's LS in Online Learning

Online learning	Acquisition			Enhancement		
	Visual	Auditory	Kinesthetic	Visual	Auditory	Kinesthetic
	Ability CT	Ability CT	Ability CT	Ability CT	Ability CT	Ability CT

As for statistical testing criteria: if the value sig > α, so Ho accepted, and Ha rejected. Instead, if sig ≤ α, Ho rejected, and Ha accepted.

RESULTS AND DISCUSSION

Result

This study aims to find out comprehensively the differences in CT proficiency improvement based on students' learning styles during online learning on algebra function derivative application materials. Furthermore, referring to the purpose of the research, several research questions are asked to achieve the intended research goals. The following is presented the results of research findings based on research questions that have been asked.

LS Tendencies that Students Have before Online Learning is Carried Out

The analysis results of students' LS tendency questionnaires were obtained from the LS questionnaire test scores of 26 students before the implementation of learning. Based on the analysis of students' LS tendencies, nine students with kinesthetic learning styles were obtained, seven with visual LS, and ten with kinesthetic LS. Visually, the tendency of student LS is shown in figure 2 below.

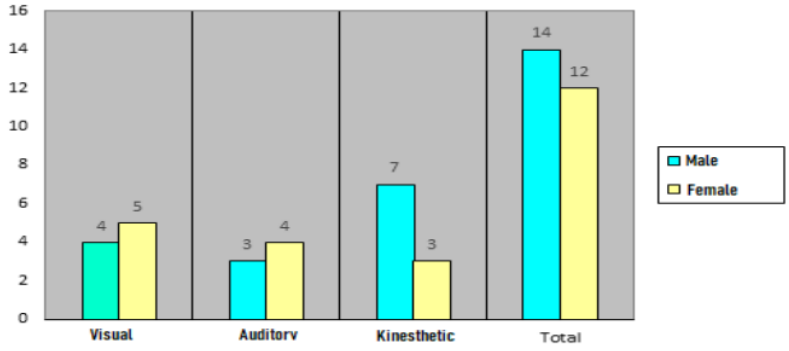

Figure 3. Student LS Tendencies

Based on Figure 3, it can be seen that, in general, kinesthetic LS is more dominantly owned by students than the other two types of LS. Judging from the gender, this kinesthetic LS is more owned by male students than female students.

The Criteria for Increasing the CT Ability of Students' LS in Online Learning

The results of descriptive analysis related to the criteria for increasing the CT ability of students who tend to LS visual, auditory, and kinesthetic in online learning are shown in Table 7.

Table 7. Descriptive Result of Improved CT Ability and LS in Online Learning

	Learning_Style		Statistic
Ngain	Visual	Mean	.8044
		Std. Deviation	.10783
		Skewness	-.986
	Auditory	Mean	.5514
		Std. Deviation	.14323
		Skewness	-.328
	Kinesthetic	Mean	.3730
		Std. Deviation	.15649
		Skewness	.806

Based on Table 7 above, the improvement of students' CT ability is greater in visual LS than in auditory and kinesthetic LS. While the improvement of the CT ability of students who are auditory LS is higher compared to kinesthetic LS. The increase criteria experienced in the three LS are in the high category for visual LS, while auditory and kinesthetic LS is in the medium category. The distribution of CT ability improvement data was more diverse experienced by students whose LS kinesthetic (s = 0.16) compared to students who were visual LS (s = 0.11) and auditory (s = 0.14). Based on skewness scores, visual LS and auditory obtain negative scores (visual LS skewness score of = -0.99, and auditory LS of = 0.33), so the graph tends to tilt negatively, which means that CT ability improvement scores tend to gather in large scores. The kinesthetic LS skewness score obtains a positive score of = 0.81. This shows the CT capability score graph tends to be skewed positively, meaning that the CT ability enhancement score gathers at a small score.

Differences in CT Abilities between LS (Auditory, Visual, and Kinesthetic) in Online Learning

CT capability acquisition scores based on LS tendencies are presented in Table 8 as follows.

Table 8. Student CT Ability Acquisition Score Based on Student's LS in Online Learning

	Acquisition		
Online learning	Visual	Auditory	Kinesthetic
	76, 86, 91, 93, 75, 93, 81, 91, 89.	78, 68, 63, 79, 76, 64, 61.	74, 67, 66, 65, 61, 62, 51, 50, 56, 62.

Furthermore, ANOVA one-way analysis is used by assuming that the post-test score comes from a normally distributed population and has a homogeneous variance. Then the results of the analysis using SPSS-26 are shown in Table 9.

Table 9. One Way ANOVA Test on CT Ability Acquisition Based on Students' LS

		Sum of Squares	df	Mean Square	F	Sig.
Post-test	Between Groups	2946.469	2	1473.235	27.191	.000
	Within Groups	1246.146	23	54.180		
	Total	4192.615	25			

Based on Table 9, a significant score (sig) = 0,000 is obtained, far below the α = 0.05, so there is a significant difference in CT ability acquisition based on student LS. Furthermore, to

find out the acquisition of better CT ability among LS students, further paca ANOVA (post hoc) tests were conducted. The findings of the analysis are shown in Table 10 below.

Tabel 10. Post-Hoc Test on Ct Ability Acquisition Based on LS

Dependent Variable	(I) Learning_Style	(J) Learning_Style	Mean Difference (I-J)	Std. Error	Sig.
Post-test	Visual	Auditory	16.25397*	3.70946	.001
		Kinesthetic	24.71111*	3.38202	.000
	Auditory	Visual	-16.25397*	3.70946	.001
		Kinesthetic	8.45714	3.62740	.071
	Kinesthetic	Visual	-24.71111*	3.38202	.000
		Auditory	-8.45714	3.62740	.071

Based on Table 10 above, it is known that there is a significant difference in the acquisition of CT abilities of students who have visual and auditory LS (sig = 0.00 < 0.05 = α). The average difference between students who have visual LS and auditory LS is 16.25. This mean difference explains that the CT acquisition of visual LS students is 16.25 higher than the average CT acquisition of auditory LS students.

Another finding in table 10 is that there is a significant difference in the acquisition of CT abilities of students with visual and kinesthetic LS (sig = 0.00 < 0.05 = α). The average difference between students who have visual LS and kinesthetic LS is 24.71. This mean difference explains that the CT acquisition of students with visual LS is 24.71 higher than the average CT acquisition of students with kinesthetic LS.

The conclusion that can be drawn from Table 10 is that there is no significant difference in the gain between ct of auditory and kinesthetic LS ability (sig = 0.07 > 0.05 = α). The acquisition of CT ability with auditory LS is not better than kinesthetic LS, where the average difference between the two is only 8.46.

Differences in the Improvement of CT Abilities between Visual, Auditory, and Kinesthetic in Online Learning

CT capability improvement scores based on LS are presented in Table 11 as follows.

Table 11. Student CT Ability Improvement Scores Based on Students' LS in Online Learning

	Enhancement		
	Visual	Auditory	Kinesthetic
Online learning	0.60, 0.78, 0.89, 0.87, 0.68, 0.91, 0.76, 0.89, 0.86.	0.69, 0.57, 0.36, 0.69, 0.68, 0.39, 0.48.	0.68, 0.57, 0.32, 0.44, 0.35, 0.33, 0.26, 0.15, 0.25, 0.38.

Furthermore, ANOVA one-way analysis is used by assuming that the increased score comes from a normally distributed population and has a homogeneous variance. Then the results of the analysis using SPSS-26 are shown in Table 12.

Table 12. One Way ANOVA Analysis of CT Improvement Based on Students' LS

		Sum of Squares	df	Mean Square	F	Sig.
Ngain	Between Groups	.885	2	.443	23.320	.000
	Within Groups	.437	23	.019		
	Total	1.322	25			

Furthermore, to find out the improvement of better CT ability among LS students, further paca ANOVA (post hoc) tests were conducted. The findings of the analysis are shown in Table

13 below. Based on Table 12, a significant score (sig) = 0.000 is obtained, far below the α = 0.05, so there is a significant difference in CT ability improvement based on the student's LS.

Table 13. Post-Hoc Test on CT Ability Improvement Based on LS

Dependent Variable	(I) Learning_Style	(J) Learning_Style	Mean Difference (I-J)	Std. Error	Sig.
Ngain	Visual	Auditory	.25302*	.06943	.004
		Kinesthetic	.43144*	.06330	.000
	Auditory	Visual	-.25302*	.06943	.004
		Kinesthetic	.17843*	.06789	.038
	Kinesthetic	Visual	-.43144*	.06330	.000
		Auditory	-.17843*	.06789	.038

Based on Table 13 above, it is known that there is a significant difference between the CT abilities of students who have visual LS and auditory LS (sig = 0.00 < 0.05 = α). The average increase in CT abilities of students who have visual LS is 0.25 higher than the average increase in CT abilities of students with auditory LS.

Another finding in Table 13 is that there is a significant difference between the CT abilities of students with visual and kinesthetic LS (sig = 0.00 < 0.05 = α). The average increase in students' CT abilities in visual LS was 0.43 higher than the average increase in students' CT abilities in kinesthetic LS.

The conclusion that can be drawn from Table 13 is that there is a significant difference between the CT abilities of students who have auditory and kinesthetic LS (sig = 0.03 < 0.05 = α). The average increase in CT ability of auditory LS students was 0.17 higher than the average increase in CT abilities of students in kinesthetic LS.

Discussion

Based on the overall data analysis, it was concluded that the tendency of the kinesthetic LS is more dominant compared to visual and auditory LS. The characteristics of visual LS are learners can remember and use the knowledge obtained at the time of delivery of materials by educators through online media (De Porter, 2010). But after the online learning process, students with visual LS have criteria for improving critical thinking skills in high categories. This is in line with previous researchers (Sari, 2014; Wahyuni, 2017) who state that students with visual LS in online learning can solve problems neatly and quickly.

The tendency of the other two LS, namely auditory LS and kinesthetic LS, have criteria for increasing CT ability in online learning in the medium category. This finding is in line with the characteristics of the tendency of auditory LS, where he has problems with works that are visualizing. Students prefer answering questions orally, discussing, and listening to explanations rather than writing. Whereas at the time of the online learning process, it is still limited to the media used by educators in conveying information to learners. However, this needs to be investigated further by using varied teaching materials with a higher level of complexity (Muali et al., 2018). Considering this study uses teaching materials that are still limited in conveying algebra function derivative application materials using google meet, it will impact students' CT ability in mastering algebra function derivative application materials for students who tend to have auditory LS and kinesthetic LS. Kinesthetic LS has a level of CT ability in online learning with medium categories. This is supported by the characteristics of kinesthetic learning styles,

where he likes to learn through manipulation and direct practice, and learners move more in doing learning activities (De Porter, 2010; Wahyuni, 2017).

The tendency of LS, which refers to the way of learning that students like, can play an important role in online learning if the educators know the student's LS before online learning is carried out. Educators can prepare more optimal teaching materials for student learning (Truong, 2016). The tendency of student LS is an important factor that strongly influences student performance in learning outcomes in developing students' CT ability in online learning. Anggrawan et al. (2019) claim that there are differences in learning outcomes between students with different LS, where male students achieve better learning outcomes than female students. Further testing needs to be investigated in online learning, where LS is important as a student learning modality. Students with all their shortcomings and advantages can adapt and acquire new knowledge and information by seeing, hearing, and doing their activities (Sari, 2014).

The implications based on research findings are students with visual LS are more dominant in online learning. It will impact students' CT ability in the online learning process in solving problems in application materials derived from algebraic functions. The tendency of auditory LS and kinesthetics is less favorable in online learning. Students with auditory LS, when experiencing network barriers, will quickly get bored.

This research is limited to the high school level, with relatively few research subjects. It is expected for future researchers to reach more varied samples, as well as a more complete and measurable methodology. However, the results of this study can be used as an alternative input for educators in improving the learning process when doing online learning, to pay attention to the tendency of students' learning styles to improve students' critical thinking skills. By knowing the learning style, educators can design online learning that varies so that it will impact all student's LS tendencies in the learning process. The results of this study are expected to help educational practitioners in conducting online learning by maximizing various learning media following student LS, for example, using layered applications, Jambods, and Miro, to assist students in realizing the ideals of Indonesian education, namely the creation of a Pancasila profile of students with critical thinking in the future.

CONCLUSIONS

The results of this study concluded that the students' CT and LS in online learning have different tendencies due to the characteristics of each diverse individual. This study showed that students with visual LS had excellent critical thinking skills, while those with auditorial and kinesthetic LS had medium critical thinking skills. In general, students with visual LS in improving CT skills in online learning can better interpret mathematical objects visually before solving mathematical problems. However, students with auditorial and kinesthetic LS still have the potential to develop their critical thinking skills.

Educators to prepare a variety of online learning media, for example, by using assistance applications such as Padlets, Jamboards, and Miro to help students understand varied LS. Then, it is also important for educators to pay attention to student LS before the learning process takes place so that it will have an impact on the CT ability of students. Educators can consider preparing, implementing, and evaluating learning, so that students still have positive potential to develop their critical thinking skills in the future. Furthermore, field conditions also need to be

understood by teachers, such as internet networks, laptop willingness, or other media that support students' online learning.

Regarding LS, it is hoped that education policymakers can provide the widest opportunity for educators to manage learning according to concrete conditions in the field. For the sake of improving the quality of education, it is expected that further research is based on the results of this study, including efforts to improve students' CT ability by considering learning styles.

AUTHOR CONTRIBUTIONS STATEMENT

M work as a conceptualization, design, writing, analysis. HRPN work as analysis, editing/reviewing, supervision. W is editing/reviewing and supervision.

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