CORRELATION STUDY OF STUDENTS' SCIENTIFIC ARGUMENTATION, CRITICAL THINKING, AND CONCEPT MASTERY ON NEWTON'S LAW OF MOTION

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Abstract

Considering the importance of each competency to the students' development then those they should have a positive correlation with each other. Therefore, this research aims to find the relation between argumentation skill, critical thinking, and concept mastery of Senior High School Students and to find their level of scientific argumentation, critical thinking, and concept mastery ability. The research used mixed-method. The qualitative data was focused on students' scientific argumentation while the quantitative data was focused on the level of variables based on the indicator, correlations between variables, and the number of students in each level of each variable. The participant in this research is senior high school students who already learned Newton's Law of motion. The critical thinking skill and concept mastery test included some different multiple-choice problems and followed by an essay of reason/ support for the answer each. While, the argumentation test formed by chained questions, including multiple choice test and essay test to figure out the Toulmin Argumentation Pattern (TAP). The test was given without giving any treatment for the participant. Based on the result concluded that: There is a very strong positive correlation between scientific argumentation, critical thinking skill, and concept mastery; While their scientific argumentation ability categorized intermediate, students' have a low grade of critical thinking skill and concept mastery.

Keywords: scientific argumentation, critical thinking skill, concept mastery

Abstract

Dengan mempertimbangkan pentingnya kemampuan berargumentasi, berpikir kritis dan penguasaan konsep dalam perkembangan peserta didik maka ketiga kemampuan tersebut harus berkorelasi positif. Oleh karenanya, dilakukan suatu penelitian yang bertujuan untuk mengetahui relasi dan tingkatan kemampuan berargumentasi, berpikir kritis dan penguasaan konsep yang dimiliki oleh peserta didik. Pada penelitian ini digunakan metode *mixed-method*. Data kualitatif terpusat pada kemampuan argumentasi peserta didik sedangkan data kuantitatif pada penelitian berfokus pada tingkat kemampuan yang dimiliki peserta didik serta jumlah peserta didik untuk masing-masing variabel berdasarkan indikator yang telah ditentukan dan korelasi antar variabel. Partisipan dibatasi pada peserta didik SMA atau sederajat yang telah mempelajari Hukum Gerak. Newton. Pertanyaan untuk kemampuan berpikir kritis serta kemampuan pemahaman konsep masing-masing terdiri dari beberapa pertanyaan berbeda yang terdiri dari pilihan ganda dan esai yang berisi alasan dari jawaban pada soal pilihan ganda. Sedangkan untuk kemampuan argumentasi soal berupa beberapa pertanyaan yang saling berkaitan yang dituangkan dalam bentuk pilihan ganda dan esai yang ditujukan untuk menggambarkan kemampuan argumentasi berdasarkan Pola Argumentasi Toulmin (TAP). Pada penelitian ini, test dilakukan tanpa memberikan perlakuan apapun terhadap partisipan. Dari penelitian ini dapat diketahui bahwa: 1. Terdapat korelasi positif yang sangat kuat antara argumentasi ilmiah, berpikir kritis, dan pengusaan konsep; 2. Tingkat kemampuan berpikir kritis dan penguasaan konsep peserta didik masih rendah, sedangkan tingkat kemampuan argumentasi ilmiah peserta didik berada pada tingkat sedang.

Kata kunci: Argumentasi ilmiah, kemampuan berpikir kritis, dan penguasaan konsep

INTRODUCTION

Education is an important aspect of human life. One of education role is to create a generation that able to solve real problems in their environment (Idris, et al., 2011). Unfortunately, based on OECD (2017), Indonesia ranked 62nd from 72 countries in the education system. Even students' performances in science worsen from 403 in 2015 to 396 in 2018 (OECD, 2019). Whereas one of PISA's scoring aspect is student ability in critical thinking. Hence, the low grade in the PISA report reflected the low level of students' critical thinking ability. However, Critical thinking skill has important roles in daily life since it urges precision in work that need more complex problem-solving ability (Cottrell, 2005), Critical thinking skill also important to support students' scientific literation (Vieira, Tenreiro-Vieira, & Martins, 2011). Students' critical thinking inabilities are caused by the teacher that never taught this ability in the learning process (Irawan, Sarwono, & Rahardjo, 2017). The learning process that emphasizes one-side information delivering from teacher to students reduce students chance to learn about critical thinking skill.

Such as critical thinking, scientific argumentation skill is a crucial competency in science education (Kuhn D. , 2010); (Zeidler & Sadler, 2008). Based on Deta, et al. (2020) Argumentation is one of important purpose in modern era of learning since it's the basic step for developing students' critical thinking and science literature. Another important value of argumentation is that argumentation able to relate and state an event with the theories, not facts only (Sandoval, 2005). Based on Kuhn & Crowell (2011) there are three categories for a good argumentation: using proof to support claim, estimating pros and contras, and estimating the positive and negative side to conclude. Yet Toulmin (2003) said, that there are three pivotal parts in argumentation (claim, support, warrant), and another three parts (rebuttal, backing, and qualifier). Further, these parts form the Toulmin Argumentation Pattern which then adapted into some indicator to determine scientific argumentation ability level.

Besides scientific argumentation and critical thinking skill, Concept mastery is also a crucial competency since its role as the basic before developing other competencies (Hidayat, 2014). Although, there are some researches state the positive relation between scientific argumentation and critical thinking ((Nurjannah & Suprapto, 2014); (Cottrell, 2005); concept mastery and Scientific argumentation (Croitoru, Thomopoulus, & Vesic, 2015); (Noviyani, Kusairi, & Amin, 2017); and the relation of critical thinking and concept mastery (Nugraha, Kaniawati, Rusdiana, & Kirana, 2016); (Satriawan, Liliasari, & Setiawan, 2018), research through overall those variables is limited.

Newton's Laws of motion were considered as very suitable for his research since it is one of material that need scientific argumentation ability (Wardani, Yuliati, & Taufiq, 2018) and existed in many events in daily life (Saglam-Arslan & Devecioglu, 2010). So, it will be related to critical urge (solving real problems), and trigger scientific argumentation. Further, the existence of Newton's Law related events in daily life need a good level of concept mastery to analyze it. Hopefully, if students have these abilities they can apply it in their daily life. Hence, this research aims to find the correlation between scientific argumentation, critical thinking skill, and concept mastery and the ability level of these variables between students in Senior High School.

METHOD

This research used purposive sampling which sample was chosen from 63 Senior high school students in MAN 2 Kota Kediri from grade 10 and 11 who learned Newton Law of Motion. Besides, they've learned Newton law of motion, other aspects such us their teacher, their gender, and their class are vary.

Data collected by giving several questions related to scientific argumentation, critical thinking, and concept mastery for Newton's law of motion. An online test using google form formed in multiple-choice problems followed by essay for the reasons/ supported theories. Collected data scored by indicators of each variable. Indicators of scientific argumentation mentioned in table 5, critical thinking in table 6 and concept mastery in table 7 (see **Appendix**).

This Research used mixed method which combines between qualitative and quantitative method (Sugiyono, 2013). The qualitative data collected by content analyzing to students answer in several chained argumentative questions for understanding students' scientific argumentation ability further. In Other hand, the quantitative data are students' level of scientific argumentation; critical thinking skill; and concept mastery, the number of the students for each variable and the correlation of these variables.

Table 1. The interpretation of Bivariate-Pearson Correlation Value

Coefficient	Interpretation
0	There is no correlation
0,01 – 0,25	Very weak correlation

Coefficient	Interpretation
0,26 – 0,50	Good correlation
0,51 – 0,75	Strong correlation
0,76 – 0,99	Very strong correlation
1,00	Perfect correlation

(Gravetter & Wallnau, 2007)

The data, then, tested by normality test to find data distribution and further the type of correlation test will be used. For normal data, the test will use the Bivariate Pearson test while for abnormal data rank Spearman test will be preferred. The test of correlation using software IBM SPSS to gain the correlation coefficient. After Bivariate - Pearson or Rank Spearman correlation coefficient obtained, the result compared with the table 1 for Bivariate – Pearson, and table 2 for Rank Spearman for knowing what kind of correlation between variables.

Table 2. The interpretation of Rank Spearman Correlation Value

Coefficient	Interpretation
0,00	There is no Relation
0,01-0,09	Meaningless Relation
0,10-0,29	Weak Relation
0,30-0,49	Moderate Relation
0,50-0,69	Strong Relation
0,70-0,89	Very Strong Relation
>0,90	Close to Perfect Relation

(de Vaus, 2002)

RESULTS AND DISCUSSION

Based on students' answer for several questions, students' ability of scientific argumentation, critical thinking skill and concept mastery scored by some indicators. Indicators of scientific argumentation mentioned in table 5, critical thinking in table 6 and concept mastery in table 7 (see **Appendix**).

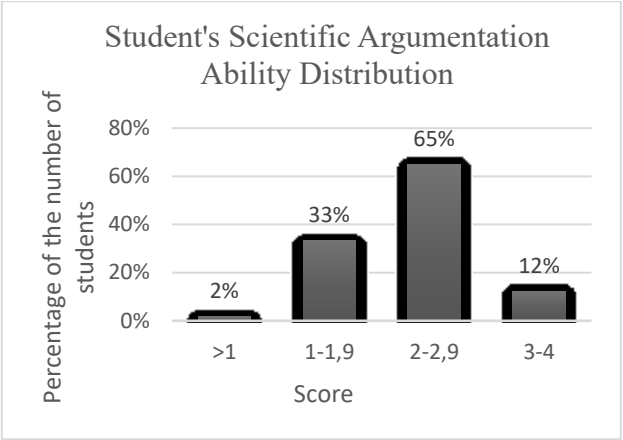

Figure 1. Students' scientific argumentation ability score distribution

The result shows that the students' scientific argumentation ability ranged in level 2 which ranged in score 2-2.9. In this level students attempt to establish an opinion or claim, students may have some error or statement which interferes with the claim. Anyway, this classified as intermediate since the maximum score is 4 and the minimum score is 0. As explained before students may have some error in explaining their argument.

Problem 1.a :
A rifle recoils are fired. The acceleration of the recoiling rifle is…. (Claim)
1. Greater than the acceleration of the bullet
2. Smaller than the acceleration of the bullet
3. The same size as the acceleration of the bullet

Answer 1.a : a. greater than the acceleration of the bullet

Problem 1.b : Is there any proof that supports your argument? Could you state it? (Ground)

Answer 1.b : Most of the students give no answer

Problem 1.c : Is there any theory that supports your argument? Could you explain it? (Warrant)

Answer 1.c : Yes, Faction = F reaction

Problem 1.d: Why do you think another option is wrong? (Rebuttal)

Answer 1.d : Most of the students give no answer

Problem 1.e : If we assume that the rifle made so light to the same weight as bullet how'd the acceleration be? (Backing)

Answer1.e : Most of the students do not answer.

Problem 1.f : Then could it be this event is one of Newton's 2nd law of motion example? (Qualifier)

Answer 1.f : yes

Here we could see that a lot of students can't state support (ground) for what they claim in the first question. This is why the scientific argumentation level stands at the intermediate level. Besides that, the students have some

error in explaining the argument. A lot of students answer problem numbers 1.c with Newton's 3rd law of motion, while they answer problem number 1.f with approving that this event is one of Newton's 2nd Law examples which mean contradict with their previous statement. Students also unable to state rebuttal which mean they could be unsure or even don't know for what they claiming about.

Another question for scientific argumentation has nearly the same score and answer pattern with the first question for most students. This question has mass and weight as the subject of discussion. Most of the questions answered but some of the answers are wrong. Students understand that the diet program has an aim to reduce mass, and that weight is influenced by mass. Yet, some of them state that weight can't be increase when the mass of subject decrease. They consist that mass of a subject are never changed.

Instead of a low level scientific argumentation ability as shown by Lubben, Sadeck, Scholtz, & Braund (2009) also Gurkan & Kahraman (2019), the result show an intermediate level of students' scientific argumentation ability. Those, could be caused by the difference level of students' thinking skill (Lin & Mintzes, 2010), unsupported teachers (Kim & Hand, 2015); (Lubben, Sadeck, Scholtz, & Braund, 2009), and students' experience in practical work (Lubben, Sadeck, Scholtz, & Braund, 2009).

Based on Gurkan & Kahraman (2019) major of students can't state support and rebuttal in their dialog. This result support our result for a similar pattern of students' argumentation structure.

While students' scientific argumentation classified as intermediate, their critical thinking categorized as emerging/low, since most of the students have score ranged from 2 to 2.9 and average score 2.4 when the maximum score is 6.

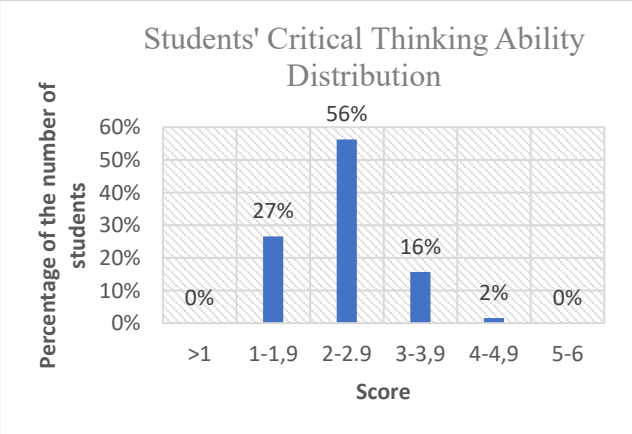

Figure 2. Students' critical thinking ability score distribution

From the graphic, we can see that there are only a few students achieve mastering/high level of critical thinking. As explained most of the students has difficulty in answering critical thinking problem.

Problem 3: if you throw a stone in the space what would happen?

1. The stone will move forever.
2. The stone will move for a few moments and then stop in the next moment
3. The stone won't ever move.

Reasons:……..

Answer: b. the stone will move for a few moments and then stop in the next moment.

Reasons: in the space, there is no gravity (gravity= 0) so there won't be free-fall motion.

Students' answer to this question seems to be very interesting. The students already understand that there is no gravity in space, yet students unable to understand the effect of zero gravity. Another problem bellow shows that the students have difficulty in differentiating between inertia and moment of inertia.

Problem 4: Tony and Budi sit in a café. After a moment they start debating about inertia. Toni state that inertia influenced by the mass of the object only while Budi consist that inertia influenced by the object's mass and speed. Which the one has the correct statement?

1. Tony Right
2. Budi Right
3. They both are wrong

Reasons:…….

Answer: Tony Right

Reasons: Moment of inertia influenced by the object's mass, shape and axis.

Most of their answers are true but their reasons are wrong. Inertia is the resistance an object has to a change in its state of motion, while the moment of inertia is a calculated measure for a rigid body that is undergoing rotational motion around a fixed axis.

Further, a research of Elisanti Evi, Sajidan, & Prayitno (2018) show a low level of critical thinking skill, supporting this research that show a low level of critical thinking skill too. This kind of result, low graded critical thinking skill, could be happened for teacher inability in training this skill in learning process (Irawan, Sarwono, & Rahardjo, 2017). Another factor such as learning method could affect students' critical thinking skill since some learning method i.e. Problem Based Learning (PBL)

improve students' critical thinking skill (Firdaus, Kailani, Bakar, & Bakry, 2015).

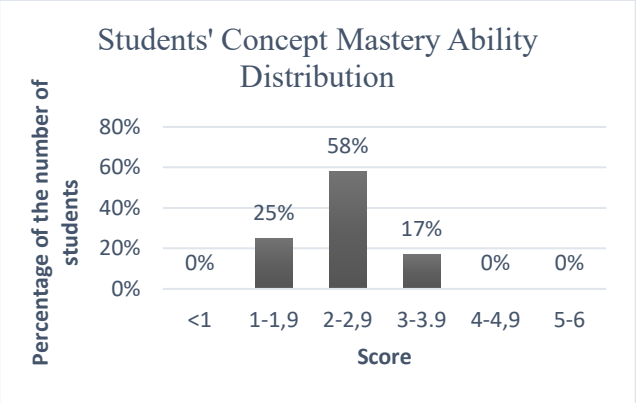

Figure 3. Students' critical thinking ability score distribution

As their critical thinking ability, students' also has a low level of concept mastery. From maximum level 6, most students only able to achieve level 2 so that the average score 2.3. For the further judgement of students' concept mastery ability, we could see this problem.

> **Problem 5:** Rocket launching is one of Newton's 3rd laws of motion event. Could you determine the action and reaction force in that event?
> **Answer:** action when gas out and push the air outside and the reaction is when the rocket launch.

From this question we can conclude that students find difficulty in understanding newton third law especially to determine action and reaction. Furthermore, some of the students unable to determine whether an event included in Newton's 3rd law of motion or not as we could see in these problems.

Same as this research, Shilla, Kusairi, & Hidayat (2017) state that students' critical thinking skill are low graded in Newton's Law of motion. The affecting factors could came from what learning method (Prima & Kaniawati, 2011), or media (Sornkhatha & Srisawasdi, 2013) used in learning activity.

Overall, there are ten problems given to the students based on scientific argumentation, critical thinking and concept mastery indicator. Unlike other indicators, which effectively used to scoring only, critical thinking indicator has some point that determines the aims that should be achieved in a question. There are seven points of critical thinking indicators used in this research. The third question attached, represent critical thinking indicator number two and also a part of concept mastery test. While the fourth question represents critical thinking indicator number five.

Question number 6 represents the critical indicator number 1. This question asked students to determine which Newton's law of motion that matched with the event. Almost half of the students answer it right. Yet some of them have imperfect reasons that downgrading their score.

Question number 7 represents critical thinking indicator of number 6 and 7 which answered right by most of the students. But unfortunately, their reasons are mostly wrong or insufficient. This question shortly asked about the relationship between mass and velocity of an object that initially rests. But, a lot of students only able to show the relation between mass and acceleration, while other students attach the relation of mass and force as their reason.

Question number 8 represents critical thinking indicator number 3. Such as question number 3, this question asked students to determine which kind of Newton's Law of motion that takes part in an event. In this question, a lot of students have the right answer and almost perfect reason.

The ninth question represents critical thinking indicator number four and a part of concept mastery test. In this question, students asked for the total force should be applied to keep an object that moves with constant velocity in the slippery road. A lot of students wrongly answer this question. They claim some number of force whereas object will remain move without needing any force since it already moves constantly in a slippery road.

The last question represents concept mastery test. In this question, students asked what will happen if a person increases his force when he pulls the wall. A lot of students answer that the wall will stand still without exploring further reason.

As explained before, besides quantitative data, qualitative data also counted. The first step is testing the data with a test of normality to determine correlation test will be used in this research. Shapiro-Wilk test of normality used since the number of the data are more than 50.

Table 3. Test of Normality Result

Tests of Normality				
Argumentation		Shapiro-Wilk		
		Statistic	df	Sig.
Critical Thinking	1	0.762	4	0.05
	1.5	0.942	7	0.66
	2	0.926	24	0.078
	2.5	0.923	12	0.314
	3	0.912	16	0.127

Tests of Normality				
Argumentation		Shapiro-Wilk		
		Statistic	df	Sig.
Concept Mastery	1	0.892	4	0.392
	1.5	0.85	7	0.123
	2	0.954	24	0.324
	2.5	0.908	12	0.199
	3	0.892	16	0.06

The result of the normality test shows that a significant number ranged on 0.05 until 0.392. This result means that the data has normal distribution for data considered normal as significant number ≥ 0.05. Therefore, this research used Bivariate-Pearson test to examine the relation of variables.

Table 4. The result of Bivariate – Pearson test

Pearson Correlation	Argu-mentation	Concept Mastery	Critical Thinking
Argumenta-tion	1	.888**	.786**
Concept mastery	.888**	1	.845**
Critical Thinking	.786**	.845**	1

Afterwards, the result of Bivariate-Pearson test compared with Table 1 to interpret whether the correlation value showing the existence of correlation or not.

Based on Table 4 the coefficient of Pearson correlation ranged on 0.786 to 0.888 hence the correlation for all variables considered as very strong correlation. The positive value of the coefficient of Pearson correlation shows a positive correlation. Correlation considered positive if both variables move in the same direction. Which mean as variable x increase variable y will increase too (Gravetter & Wallnau, 2007). This means, that the critical thinking skill, and concept mastery increase as the scientific argumentation increase, vice versa.

Since the result show a low grade in both critical thinking skill and concept mastery, therefore, students need to develop further of these competencies especially for critical thinking and concept mastery and even though students' scientific argumentation ability is in intermediate level further development are suggested for the advantages it has, since they aren't able to state some part of argumentation such as ground and rebuttal.

There are a lot learning method that able to improve scientific argumentation i.e. guided discovery (Rahmawati & Suprapto, 2019), buzz group typed discussion learning method (Hikmah & Suprapto, 2019) or argument driven inquiry (ADI) (Bestiantono, 2020) which improve not only argumentative skill but also students' scientific literacy. Yet these methods mostly improve students' scientific argumentation only.

Based on Efendi, et al (2020), Socratic Method has significant roles in improving Socratic Critical thinking. Another similar result of research by Iqrammah & Kusnan (2015) and Nurjannah & Suprapto (2014) shown that the Socratic Method has a positive correlation to critical thinking skill. Further, Socratic Method has some significant role in improving (Suardana, Liliasari, & Ismunandar, 2013) and examining concept mastery (Meyer & Land, 2006); also in presenting availability to students to be linked with argumentation practices. Moreover, Socratic Method has been proven to have students enthusiasm (Suprapto & Dwikoranto, 2011). Since, the positive correlation of Socratic Method with scientific argumentation, critical thinking, and concept mastery, the application of Socratic Method in learning activity suggested.

CONCLUSION

From the result, we can conclude that scientific argumentation, critical thinking skill and concept mastery has a very strong correlation. Therefore, students need to develop further of these competencies especially for critical thinking and concept mastery which low categorized and even though students' scientific argumentation ability is in intermediate level, for students' inability to state some part of argumentation such as ground and rebuttal, further development using Socratic learning method suggested.

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APPENDIX

Table 5. Scientific argumentation skill indicator

(Data Recognition Corporation, 2016)

No	Indicator	Score
1	• "Effectively introduces an opinion or claim" • "Uses logical, credible, and relevant reasoning and evidence to support opinion or claim" • "Uses an organizational strategy to present reasons and relevant evidence" • "Acknowledges and counters opposing claims, as appropriate" • "Uses precise and purposeful word choice" • "Uses words, phrases, and/or clauses that effectively connect and show relationships among ideas" • "Uses and maintains an appropriate tone" • "Provides a strong concluding statement or section that logically follows from the ideas presented" • "Has no errors in usage and conventions that interfere with meaning"	4
2	• "Clearly introduces an opinion or claim" • "Uses reasoning and evidence to support opinion or claim" • "Uses an organizational structure to present reasons and relevant evidence" • "Attempts to acknowledge and/or counter opposing claims, as appropriate" • "Uses clear word choice" • "Uses words and/or phrases to connect ideas" • "Uses an appropriate tone" • "Provides a concluding statement or section that follows from the ideas presented" • "Has few, if any, errors in usage and conventions that interfere with meaning"	3
3	• "Attempts to establish an opinion or claim" • "Develops, sometimes unevenly, reasons and/or evidence to support opinion or claim" • "Attempts to use an organizational structure" • "Makes little, if any, attempt to acknowledge or counter opposing claims" • "Uses simple language, which sometimes lacks clarity" • "Provides a weak concluding statement or section" • "May have errors in usage and conventions that interfere with meaning"	2
4	• "Weakly states or alludes to an opinion or claim" • "Has minimal support for opinion or claim" • "May be too brief to demonstrate an organizational structure" • "Makes no attempt to acknowledge or counter opposing claims" • "Uses words that are inappropriate, overly simple, or unclear" • "Provides a minimal or no concluding statement or section" • "Has errors in usage and conventions that interfere with meaning"	1
5	• "The response is completely irrelevant or incorrect, or there is no response"	0

Table 6. Critical thinking skill indicator

(Washington State University, 2006)

Rating Criteria	Rating Scale					
	Emerging		**Developing**		**Mastering**	
Summarized problem, question, or issue	"Does not attempt to or fails to identify and summarize accurately."		"Summarizes issue, though some aspects are incorrect or confused. Nuances and key details are missing or glossed over."		"Clearly identifies the challenge and subsidiary, embedded, or implicit aspects of the issue. Identifies integral relationships essential to analyzing the issue."	
	1	2	3	4	5	6
Considers context and assumptions	"Approach to the issue is in egocentric and socio-centric terms. Does not relate to other contexts. Analysis is grounded in absolutes, with little acknowledgement of own biases. Does not recognize context and underlying ethical implications."		"Presents and explores relevant contexts and assumptions, although in a limited way. Analysis includes some outside verification, but primarily relies on authorities. Provides some consideration of assumptions and their implications."		"Analyzes the issue with a clear sense of scope and context, including an assessment of audience. Identifies influence of context. Questions assumptions, addressing ethical dimensions underlying the issue."	
	1	2	3	4	5	6
Communicates <u>own</u> perspective, hypothesis, or position.	"Position is clearly adopted with little consideration. Addresses a single view of the argument, failing to clarify the position relative to one's own. Fails to justify own opinion or hypothesis is unclear or simplistic."		"Presents own position, which includes some original thinking, though inconsistently. Justifies own position without addressing other views or does so superficially. Position is generally clear, although gaps may exist."		"Position demonstrates ownership. Appropriately identifies own position, drawing support from experience and information not from assigned sources. Justifies own view while integrating contrary interpretations. Hypothesis demonstrates sophisticated thought."	
	1	2	3	4	5	6
Analyzes supporting data and evidence	"No evidence of selection or source evaluation skills. Repeats information without question or dismisses evidence without justification. Does not distinguish between fact and opinion. Evidence is simplistic, inappropriate or not related to topic."		"Demonstrates adequate skill in selecting and evaluating sources to meet information need. Use of evidence is selective, discerns fact from opinion and may recognize bias. Appropriate evidence is provided although exploration is routine."		"Evidence of source evaluation skills. Examines evidence and questions accuracy and relevance. Recognizes bias. Sequence of presentation reflects clear organization of ideas, subordinating for importance and impact."	
	1	2	3	4	5	6

Rating Criteria	Rating Scale					
	Emerging		**Developing**		**Mastering**	
Uses other perspectives and positions	"Deals with a single perspective and fails to discuss others' perspective. Adopts a single idea with little question. Alternatives are not integrated. Ideas are obvious. Avoids discomforting ideas. Treats other positions superficially. No evidence of self-assessment."		"Begins to relate alternative views. Rough integration of multiple viewpoints. Ideas are investigated in a limited way. May overstate conflict or dismiss alternative views hastily. Analysis of other views mostly accurate. Some evidence of self-assessment."		"Addresses diverse perspectives from a variety of sources to qualify analysis. Any analogies are used effectively. Clearly justifies own view while respecting views of Others. Analysis of other positions is accurate and respectful. Evidence of reflection and self-assessment."	
	1	2	3	4	5	6
Assesses conclusions, implications, and consequences	"Fails to identify conclusions, implications, and consequences, or conclusion is a simplistic summary. Conclusions are absolute, and may attribute conclusion to external authority."		"Conclusions consider evidence of consequences extending beyond a single issue. Presents implications that may impact other people or issues. Presents conclusions as only loosely related to consequences. Implications may include vague reference to conclusions."		"Identifies and discusses conclusions, implications, and consequences. Considers context, assumptions, and evidence. Qualifies own assertions. Consequences are considered and integrated. Implications are developed and consider ambiguities."	
	1	2	3	4	5	6
Communicates effectively	"In many places, language obscures meaning. Grammar, syntax, or other errors are distracting or repeated. Little evidence of proofreading. Style is inconsistent or inappropriate. Work is unfocused and poorly organized; lacks logical connection of ideas. Format is absent, inconsistent or distracting. Few sources are cited or used correctly."		"In general, language does not interfere with communication. Errors are not distracting or frequent, although there may be some problems with more difficult aspects of style and voice. Basic organization is apparent; transitions connect ideas, although they may be mechanical. Format is appropriate although at times inconsistent. Most sources are cited and used correctly."		"Language clearly and effectively communicates ideas. May at times be nuanced and eloquent. Errors are minimal. Style is appropriate for audience. Organization is clear; transitions between ideas enhance presentation. Consistent use of appropriate format. Few problems with other components of presentation. All sources are cited and used correctly, demonstrating understanding or economic, legal, and social issues involved with the use of the information."	
	1	2	3			1

Table 7. Concept mastery indicator

(Anderson & Karthworl, 2001)

Definition	Bloom's Definition	Skor
C1	"Exhibit memory of learned material by recalling facts, terms, basic concepts, and answers"	1
C2	"Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving, description, and stating main ideas."	2
C3	"Solve problems to new situations by applying acquired knowledge, facts, techniques and rules, in a different way."	3
C4	"Examine and break information into part by identifying motives or causes. Make interferences and find evidence to support generalization."	4
C5	"Present and defend opinions by making judgements about information, validity of ideas, or quality of work based on a set of criteria"	5
C6	"Compile information together in a different way by combining elements in a new pattern or proposing alternative solutions."	6

Questions

1. **Problem 1.a** :
   A rifle recoils are fired. The acceleration of the recoiling rifle is…….. (Claim)
   1. Greater than the acceleration of the bullet
   2. Smaller than the acceleration of the bullet
   3. The same size as the acceleration of the bullet

   Answer1.a : ……
   Problem1.b : Is there any proof that supports your argument? Could you state it? (Ground)
   Answer1.b : ……
   Problem1.c : Is there any theory that supports your argument? Could you explain it? (Warrant)
   Answer1.c : ……
   Problem1.d : Why do you think another option is wrong? (Rebuttal)
   Answer1.d : ……
   Problem1.e : If we assume that the rifle made so light to the same weight as bullet how'd the acceleration be? (Backing)
   Answer1.e : ……
   Problem 1.f : Then could it be this event is one of Newton's 2nd law of motion example? (Qualifier)
   Answer 1.f : ……
2. **Problem 2.a** : Elisa doing a dietary program. Which one is correct (Claim)
   a. Elisa Try to reduce her weight
   b. Elisa try to reduce her mass

   Answer 2.a : ……
   Problem 2.b : Is there any proof that supports your argument? Could you explain it? (Ground)
   Answer 2.b : ……
   Problem 2.c : For another option that you didn't choose, could it happen? Please, explain. (Rebuttal)
   Answer 2.c : ……
   Problem 2.d : Is it possible if both of those options realized at the same time? Why? (Warrant)
   Answer 2.d : ……
   Problem 2.e : How is Elisa's Weight in the space? (Backing)
   Answer 2.e : ……
   Problem 2.f : Is it possible that when the mass decrease the weight increase? (Qualifier)
   Answer 2.f : ……
3. **Problem**: If you throw a stone in the space what would happen?
   a. The stone will move forever.
   b. The stone will move for a few moments and then stop in the next moment
   c. The stone won't ever move.

Reasons: ……

4. **Problem**: Tony and Budi sit in a café. After a moment they start debating about inertia. Toni states that inertia influenced by the mass of the object only while Budi consist that inertia influenced by the object's mass and speed. Which one has the correct statement?
   a. Tony Right
   b. Budi Right
   c. They both are wrong

   Reasons: ……
5. **Problem**: Rocket launching is one of Newton's 3rd law of motion event. Could you determine the action and reaction force in that event?

   Answer: ……
6. **Problem**: Just after a rifle fired, it will move to the back. Which Newton's Law of motion discuss this phenomenon?
   a. Newton's 1st law of motion
   b. Newton's 2nd law of motion
   c. Newton's 3rd law of motion
   d. Newton's 1st and 2nd law of motion
   e. Newton's 1st and 3rd law of motion
   f. Newton's 2nd and 3rd law of motion
   g. All of Newton's law of motion

   Answer : ……
   Reason : ……
7. **Problem**: Rika has two boxes of apple. The first box(B1) full of apple while another box(B2) only half-filled. If those boxes pulled by Rika with the same amount of force. What is those boxes velocity after 2 seconds?
   a. B1 faster than B2
   b. B1 slower than B2
   c. Both of those boxes have the same velocity

   Answer: ……
8. **Problem**: Have you ever see the bird flies on the sky. In your opinion which Newton's Law of motion mentioned this event?
   a. Newton's 1st law of motion
   b. Newton's 2nd law of motion
   c. Newton's 3rd law of motion
   d. Newton's 1st and 2nd law of motion
   e. Newton's 1st and 3rd law of motion
   f. Newton's 2nd and 3rd law of motion
   g. All of Newton's law of motion

   Answer: ……
9. **Problem**: An object moved with a constant speed of 50km/hour in a slippery way. If the object has 5 kg mass, how much force needed to keep that object moves?

   Answer: ……
10. **Problem**: Andi pulls a wall with 700N force. If Andi increases the force he used for pulling the wall to be 900N. What would happen?

    Answer: ……