
Mathematics students' writing skills: Assesment in higher education with Rasch model

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ABSTRACT

The aim of this research is to describe the students' scientific writing skills of mathematics education. This research is descriptive qualitative research. Research subject is chosen by using purposive sampling technique. Research subject is chosen based on variety of batch, grade point average (GPA) dan Thesis Processing Duration (TPD). Data collection techniques in this research are document studies (documentation methods) and interviews. The document study was carried out by 2 researchers (chairman and researcher members) and 2 other lecturers of Mathematics Education Study Program to obtain data about writing scientific work for research subjects. The interview was conducted after the results of the first data analysis were obtained as confirmation media and deeper exploration of the profile of the research subjects. This study provides an overview of the carrying capacity of the GPA characteristics, the value of Indonesian Language, the value of Research Methods, and TPD. The four characteristics do not significantly support the students' scientific writing skills of the mathematics education study program.

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1. INTRODUCTION

The need of development scientific writing skills is very important considering the results of the final assignment of students in the form of mini-thesis will continue to increase in quantity along with the increase in alumni (Clarke et al., 2013; Derish et al., 2007; Greenberg, 2015; Pelger & Sigrell, 2016). The increasing quantity of thesis is expected to be in line with the increasing quality of the mini-thesis. One of the expectations of a quality mini-thesis is the increasing number of theses that successfully qualify in journals with good reputation and relevant to science in the mini-thesis content. With good publication, the results of research can be used more widely (Skulmoski, Hartman, & Krahn, 2007).

Based on SNPT number 44-year 2015, scientific publications are a necessity for research with non-confidential nature. Seeing the importance of research and scientific publications in order to encourage research in university that is beneficial to the community, the skill of writing good scientific work is an important thing to become the focus of development (Barbot et al., 2012; Calkins & Ehrenworth, 2016; Ohri & Dawes, 2009). These skills become important skills possessed by students as one of the research implementers in universities. The skill of writing

scientific papers is something that must be owned by students as a pre-requisite to becoming a graduate (Prahmana, 2017).

Based on the observation of the researcher as a supervisor and examiner of mini-thesis in the last 2 years, the quality of the mini-thesis produced by students in order to complete the final assignment continues to improve. This was viewed from the quality of the problem, the research method, the presentation of the research results, and recommendations for suggestions aimed at the development of research. Other things that are evidence of an increase in the quantity of research results (some or all of the thesis) that qualify for publication in journals with good reputation and relevant to science in the content of the thesis. For example, a student published research article in the Mosharafa journal (Rani, Niswah, & Agustiani, 2017).

By looking at the number of published student research articles and the number of articles that have the chance to be published, optimism continues to be built in the student mindset when writing the final assignment that the research results should not be stored as unpublished mini-thesis. In addition to building a new mindset, Mathematics Education Study Program UIN Raden Fatah also plans to make a new regulation regarding the obligation of students to publish a research article which is part of their final assignment. This policy plan is also supported by a study program in evaluating curriculum and Standard Operating Procedure (SOP) regarding student final assignment writing. The evaluation activity is expected not only based on anxiety, but can be based on the results of the research.

The skill of writing scientific papers is a person's skill in expressing ideas in the form of thinking, experience, knowledge, and other knowledge into written and systematic forms of language in order to become a reference for others (Prahmana & Kusumah, 2016). Writing skills include the skills of forming words, a combination of words, single sentences, compound sentences, paragraphs, and collection of paragraphs forming a whole idea. In addition, writing also emphasizes the use of affixes and punctuation. Furthermore, Writing is a highly complex process for novice and non novice writers alike since it involves a host of advanced skills that include critical thinking, logical development, and coherence of ideas (Almaden, 2006). Table 1 shows indicators of the skill of writing scientific works derived from *Ejaan Yang Disempurnakan/EYD* (Indonesian Standard of Spelling) rules (*Pusat Pembinaan dan Pengembangan Bahasa*, 1992).

Table 1. Indicator of writing skills

Indicator	Sub-indicator
The Use of <i>EYD</i>	<ol style="list-style-type: none"> 1. The use of capital and italic letter 2. The use of punctuation 3. The use of standard word 4. The use of affixes dan preposition
Sentence Effectiveness	<ol style="list-style-type: none"> 1. The selection of diction 2. The used of conjunction 3. Double meaning in sentences
Paragraph Construction	<ol style="list-style-type: none"> 1. The flow of ideas in the background 2. The connction between paragraphs 3. The idea of paragraph
Reference Writing	<ol style="list-style-type: none"> 1. Writing of citation 2. Writing of Bibliography

Based on the results of the researchers' initial studies, the characteristics that support the quality of the mini-thesis and become a description of the skills of writing scientific papers are

academic achievement. The academic achievement includes the value of courses that contain language skills, and content skills both math and mathematics education which can be seen by the Grade Point Average (GPA). Another characteristic that can support research skills and scientific writing skills is research experience, especially in following research conducted by lecturers. In addition, it is also studied the characteristics that can be a description of research skills and scientific writing skills, namely the final value obtained by students in the Result Seminar and *Munaqosyah* exam and reputation of the journal that published the research results.

The preliminary study of the description of research skills and writing skills of scientific work is carried out by observing the process and results of the completion of the final project (mini-thesis) conducted by several students. Observations were made on several subjects with different characteristics. The object of observation is still limited to the number and content of mini-thesis guidance cards and the final grades obtained by students on the Result Seminar and *Munaqosyah* exam. Based on observations found results that are not always in accordance with the initial study, for example research subjects with a low GPA, produce a mini-thesis with the good values in Seminar and *Munaqosyah*. It is concluded from 20 subjects that there are low correlation between GPA and values in Seminar and *Munaqosyah*.

The aim of this research is to describe the students' scientific writing skills of mathematics education. This result of this research is useful to give framework about students' initial skill as starting point of students' development scientific writing skill. In order to build a research theoretical framework, the consideration of previous research is important. This research is supported by several relevant studies. Relevant research includes research on profile of student candidates for mathematics teachers in carrying out learning to support student final assignment research and design research-based research that produces Hypothetical Learning Trajectory (HLT) to support the ability to research and write student scientific work. Agustiani (2015) reported that the students of mathematics education have the good ability in teaching to carry out research as a final project. Also, Pedagogical Content Knowledge (PCK) level of students can be developed through lecture activities and practical experience. Prahmana & Kusumah (2016) produced HLT that successfully supports learning in mathematics education research courses. Based on their research, the resulting HLT could support the improvement of student's research and writing skills.

2. METHOD

This research is a mix methods research that combines quantitative and qualitative approaches. In this study the results of research obtained from one data collection technique are combined with other data collection techniques (Creswell & Clark, 2017). The strategy of the explanatory stages begins with collecting and analyzing quantitative data and then by collecting data and analyzing it quantitatively based on the initial data. The strategy was chosen to map students' writing skill ability profiles quantitatively and followed by an in-depth study of research subjects qualitatively techniques. The priority weight lies in the results of the first data analysis, namely quantitative data.

The selection of research subjects was preceded by a preliminary study of student final project documents. The selection of research subjects was conducted by purposive sampling technique where the research subjects were selected based on the variation of the class, the Grade Point Average (GPA) with the category, and the Mini-Thesis Duration (MTD). The three considerations aim to look at profiles of various subject characteristics. Many research subjects

were selected from the class of 2012, 2013, and 2014, each of the 2 research subjects. The research subject category is presented in Table 2.

Table 2. The category of research subject

No	Batch	GPA	MTD	LV	MV	IRS
1	2012	L	L	B	B	Sk
2	2012	H	S	B	A	IO
3	2013	L	L	A	B	EA
4	2013	L	S	A	B	TI
5	2014	H	S	B	A	PW
6	2014	H	S	B	A	AN

Explanation:

GPA: grade-point average; L: Low; H: High;

MTD: Mini-Thesis Duration; L: Long; S: Short

BV: Bahasa Indonesia Value

MV: Research Method Value

IRS: Initial of Research Subject

In order to achieve the objectives of this study, a mixed methods study was conducted to map skills profiles quantitatively using the results of document assessment (document study) which were analyzed with the Rasch model followed by an in-depth study of research subjects qualitatively with interview techniques. The document assessment activity was carried out by filling out a checklist instrument which had been prepared as many as 21 statements derived from the indicators of writing scientific papers.

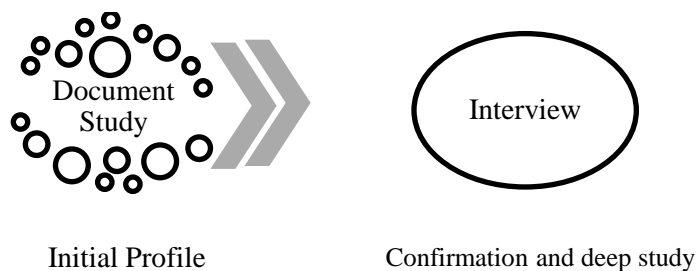


Figure 1. Collecting data techniques

The results of the study documents in the form of thesis assessments and other document checklists on the research subject category are described qualitatively the skill. The response results were then analyzed qualitatively with the Rasch Model assisted by Minifac software to help complete the profile description. As additional information and reinforcement of the results of the analysis will be presented the results of the analysis of the rater. The following is the flow of data analysis activities from the study documents.

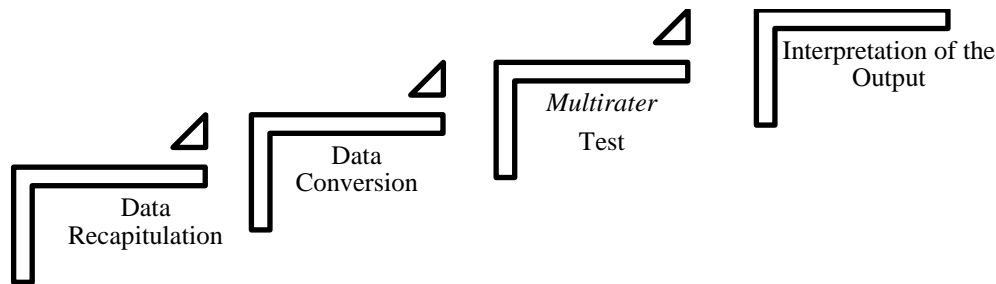


Figure 2. The flow of data analyzed of document study

Analysis data of research from document studies was carried out by Multirater Test. Multirater tests were conducted to determine whether there were bias indications in the results of the rater which is caused by the research subject, instrument item, rater and mapping the logit of research subject, instrument item, and rater (Sumintono & Widhiarso, 2014). The Multirater test begins by preparing data from the assessment of the four raters for the six research subjects. The assessment form consists of 18 statements for research skills and 21 statements for the skill of writing scientific papers. Multirater test analysis was performed using the help of Minifac software. The following are the steps for implementing the rater test (Sumintono & Widhiarso, 2014).

- 1) Creating special files in the form of command lines (coding) as well as making a program for a particular task. To make it easier to copy assessment data, assessment data from recapitulation tables are separated by skill and stored in separate files. Then, the Microsoft Excell file is saved (save as) in the form of Formatted Text (Space Delimited) with the extension "prn". Files with the extension "prn" are opened (open with) with the notepad application to simplify the writing of command lines (coding).
- 2) Open the file generated in the previous step using Minifac software by sliding the file towards the application.
- 3) Press enter twice to bring up the analysis results in general.
- 4) To bring up the results of a particular analysis, the desired output can be selected in the Outputs Tables and Plots menu. To bring up the bar Vertical Size (vertical ruler), select Table 6 in the output tables and plots menu and select Permanent Output to get results that can be stored in the form of a notepad file. Analysis of research data to interpret vertical ruler contents is done to draw conclusions about the subject's logit map (student), item, and rater; and unexpected assessment results (indications of bias assessment) (Sumintono & Widhiarso, 2014). The logit value is directly proportional to the skill of the research subject, the difficulty of the item/item statement is fulfilled, and the low value given by the rater. So that, through vertical ruler results can be mapped the skills of research subjects, items that are most fulfilled and at least fulfilled, and rater who are the most "hard" or "easy" provide value.
- 5) To bring up the Measurement Report Table for subjects, items, and raters, save the first output in the form of a notepad file. Conclusions that obtained about the consistency of the value obtained by the research subjects from the four raters, the value given by the rater to the subject, and the consistency of items for all subjects from all raters. From the output of the Measurement Report Table (arranged by mN), the value of the person reliability sample is obtained. The following is a table of reliability value categories.

Table 3. The category of reability value (Sumintono & Widhiarso, 2015)

No.	Interval	Criteria
1	< 0.67	Weak
2	0.67-0.80	Fair
3	0.81-0.90	Good
4	0.91-0.94	Very Good
5	> 0.94	Excellent

After the implementation of the first data collection technique, the quantitative data obtained was analyzed. Then, the results of the data analysis are interpreted to contain the initial profile of research skills. The initial profile is a benchmark for the development of interview guidelines that focus to two subjects with unpredictable results of the analysis. Interviews are conversations carried out by two people for a specific purpose (Young et al., 2018). The interview was conducted after the results of the first data analysis were obtained as confirmation media and deeper excavations regarding the profile of the research subjects. Interviews were conducted to explore information on the characteristics of the research subjects. The focus of the interview is about the results of data analysis that do not match the theoretical predictions of the researcher. Interviews were carried out in writing to the six research subjects. Analysis of interview data is described qualitatively based on data confirmation needs. The qualitative data analysis phase includes the stages of data reduction, data presentation stage, and the stage of drawing conclusions (Creswell, 2012). The following are the stages that are passed in order to analyze the interview data.

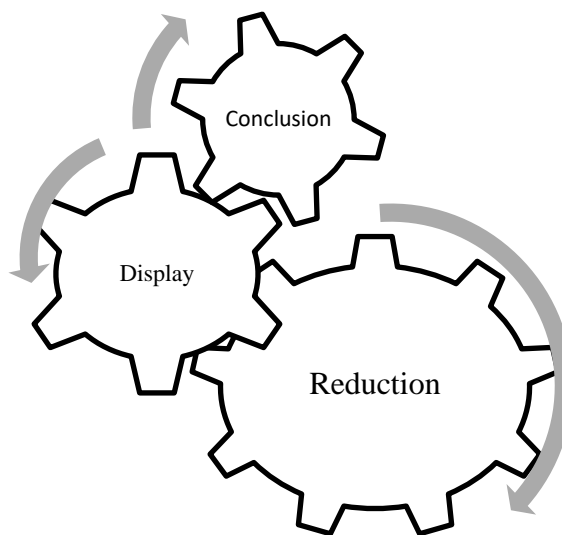


Figure 3. The flows of interviews data analysis

In this study, the validity of the data is guaranteed by triangulation which is interpreted as a data collection technique that combines data from various existing techniques and data sources (Creswell, 2012). The triangulation carried out in this study used triangulation techniques. In triangulation techniques, researchers used document study techniques and interviews to describe the profile of the subject of research on research skills and writing scientific papers.

3. RESULTS AND DISCUSSION

Research instruments that have been arranged examined by expert. Expert selection considers the period of work as a lecturer, the level of education, and the quantity and quality of research that has been carried out. The expert was a lecturer Literature and Language Education, ES. The expert focus on indicators and assessment points for the ability to write scientific papers. The second expert assessed that the indicators and sub-indicators were appropriate, and the items contained in the assessment sheet were sufficient to describe the skills of writing scientific papers. The second expert corrects several statements so that each statement contained in the assessment sheet is parallel (congruent).

The document study begins with an assessment of the completeness and adequacy of the document. After the collected documents are complete and sufficient, the assessment process is followed by mini-thesis assessment written by the research subject as a final assignment. The implementation of the document study was carried out by filling out the assessment sheet in the form of a checklist and qualitative description. The document assessment activity was carried out by filling out a checklist instrument which had been prepared as many as 21 statements derived from the indicators of writing scientific papers. Thesis was assessed by 2 researchers and 2 lecturers of Mathematics Education.

The results of writing scientific papers assessment are then converted into scores, 0 for responses "No" and 1 for responses "Yes". The results of the conversion from the assessment of the four raters to 6 research subjects were recapitulated and presented in table form. From the data recapitulation table, it can be seen manually which indicators are not met and which indicators are met by all research subjects according to all raters. However, these results are still too general, so the results are not enough to be used as a benchmark for drawing conclusions. For this reason, a Rater Test was conducted on the results of the assessment of the writing skills of scientific papers consisting of 21 items. After analyzing the results of the Rater Test on 21 items of statements for writing skills, some conclusions were obtained. The following are conclusions regarding the subject, logit map, item, and rater.

- 1) Based on the logit map of items in Figure 4, it is interpreted that 50% of items on the assessment sheet are above logit 0.00. It means that the items is difficult to be fulfilled by research subject. The items at least fulfilled by research subjects were item no. 19, followed by items no. 17, and 15. The items are about the variations of citation writing and the paragraph writing with clear main ideas and sufficient supporting sentences. Whereas, items that can be fulfilled by all subjects based on the results of the four raters are item no. 4 which contains the use of exclamation marks, question marks, and quotation marks for sentences that are in accordance with *EYD* rules.

Another interpretation of the items obtained from the results of this analysis is about the consistency of items to be assessed against a variety of research subjects and by various raters. From the output table (Item Measurement Report (arranged by mN)), it was found that the person reliability of the sample was 0.59. The value of person reliability in the range 0.67-0.80 indicates that the consistency of items is weak.

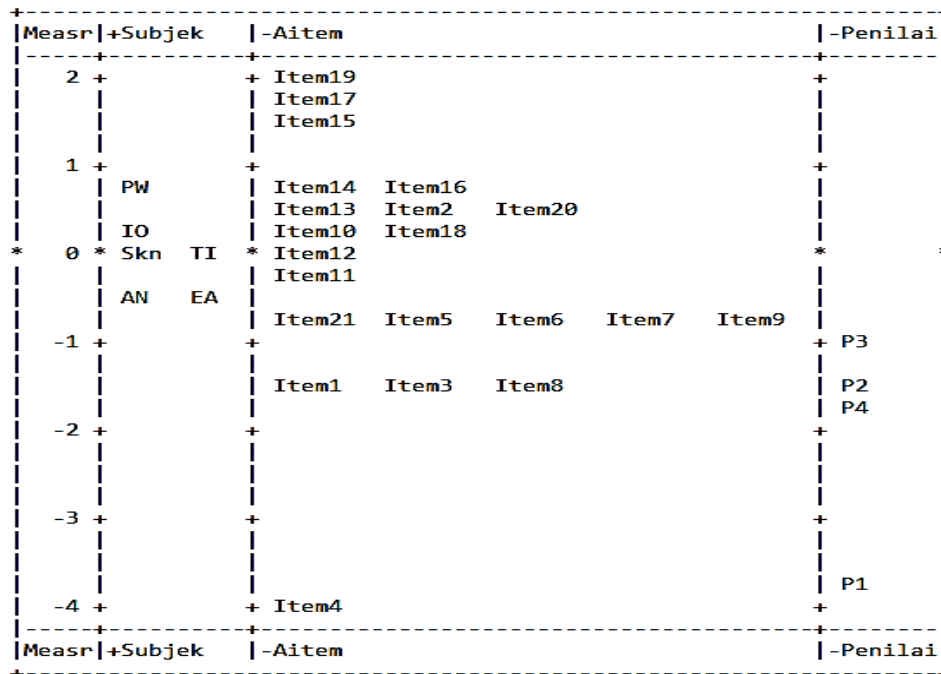


Figure 4. Vertical ruler of writing skill

- Based on the Vertical Ruler Map Figure 4, it is interpreted that the first rater is the rater with the lowest logit, while the third rater is the rater with the highest logit. It means that the first rater is the easiest rater in providing value, while the third rater is the hardest rater. This result also shows that the rater is consistent in terms of assessing the ability to write scientific work.

The consistency of the value given to the research subject can also be seen using the measure of the person reliability sample. From the output table (Measurement Report Assessment (arranged by mN)), it was found that the person reliability of sample was worth 0.93. The value of person reliability in the range 0.91-0.94 shows that the consistency of the assessor is excellent.

- Based on the logit map in Figure 4, it is interpreted that there are 2 subjects with values above the logit value of 0.00, 2 subjects with a logit value of 0.00, and 2 subjects with a value below the logit value of 0.00. Subject PW had the highest scores, subject EA and subject AN had the lowest scores.

From the logit value it can be concluded that the subject PW with the characteristics of the GPA in the high category, the value "B" for Bahasa Indonesia course and "A" for Research Method, and the Mini-Thesis Duration (MTD) in the short-term category, had the best writing skills. While the lowest writing skills was obtained by subject AN and EA. AN is the research subject with the characteristics of GPA in the high category, the value "B" for Bahasa Indonesia course and "A" for Research Method, and the Mini-Thesis Duration (MTD) in short-term category, EA is the research subject with the characteristics of GPA in the low category, the value "A" for Bahasa Indonesia course and "B" for Research Method, and the Mini-Thesis Duration (MTD) in long-term category. The following

tabulations are presented which contain a recapitulation of the order of writing research subject's level of ability supplemented by information about the characteristics of the research subject.

Table 4. Recapitulation of students' characteristics and writing skill

No	Initial of Subject	Characteristics				
		Batch	GPA	LV	MV	MTD
1	PW	2014	H	B	A	S
2	IO	2012	H	B	A	S
3	SKn	2012	L	B	B	L
4	TI	2013	L	A	B	S
5	AN	2014	H	B	A	S
6	EA	2013	L	A	B	L

Based on Table 4, it can be observed that two of the four characteristics observed actually support the high value of writing skills. The GPA in the high category and the duration of thesis work in the short-term category support the writing skills of subject IO and PW, but fail to predict writing skills of subject AN that get low score. Whereas, the characteristics of the Indonesian Language which theoretically support writing skills, based on the results of the analysis have no role in supporting writing skills.

Another conclusion about the research subject obtained from the results of this analysis is about the consistency of the values obtained by the research subjects from the four raters. From the output table (Subject Measurement Report (arranged by mN)), it was found that the person reliability of the sample was worth 0.54. The value of person reliability in the range of 0.67 indicates that the consistency of the value obtained by the research subject is weak.

Based on the 3 the interpretation of students' writing skill, there are 2 conclusions in general. The first conclusion regarding the consistency of the value obtained by the subject, given by the researcher, emerged from each item. Only researchers consistently produce excellent grades with category "very consistent". Whereas, subjects and items are consistent in the weak category. The second conclusion is about the initial profile of writing scientific papers. The initial profile was obtained that the research skills of students (research subjects) were more dominant above the average, with dominant difficulties in paragraph formation.

The initial profile is a benchmark for the development of interview guidelines whose main focus is two subjects with unpredictable results of the analysis. The first subject is SKn which has a less supportive characteristic, but the value of the skill of writing scientific work is high. The second subject is AN which has sufficiently supportive characteristics, but the value of the skill of writing scientific work is low. Both of these subjects became the focus of the interview.

Based on the interpretation of the interview results, it was found that the general conclusions regarding the profile of the writing skills of students of the Mathematics Education Study Program. Some points of conclusion obtained include,

- 1) The carrying capacity of Indonesian Language courses towards the completion of students' mini-thesis is low. The content needed to support the skills of writing scientific papers is

content about the preparation of paragraphs and preparation of scientific work with project-based learning.

- 2) The research subject with the high scores for writing scientific papers skill had good quantity and quality of reading and high research motivation.
- 3) The research subjects with the low scores for write scientific papers skills had problems in the preparation of learning instruments and data collection instruments.

In Table 4, it can be seen about the skill of write scientific papers. Recapitulation of writing skills was obtained after study of subject research documents, filling out checklist sheets and interviews. As well as the value of courses considered in writing skills are Indonesian courses. Indonesian Language courses have a large role in the quality of student writing skills (Hartati, 2017).

Based on recapitulation of students' characteristics and writing skill in Table 4, it can be seen that subjects who have a very good Indonesian Language course score are in the lowest writing ability category, namely the EA subject. While subjects with good grades are classified as the highest writing abilities. Based on the results of the interview, it was also obtained information that the research subjects still felt difficulty in pouring what they thought into writing. In addition, all subjects agreed that arranging one paragraph with the ideal sentence arrangement is not easy. So that it can be seen in the research subject's thesis that there are several paragraphs whose sentences are not related. This can be seen from the results of the assessment of all the assessors of almost all research subjects who stated the lack of skills of the research subject in arranging paragraphs.

Table 5. Writing paragraphs items score of students's writing skill

The ideas of the paragraph are connected	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	1	
The idea of the paragraph is clear	1	0	0	1	1	0	1	1	1	0	0	0	1	0	1	1	1	0	1	1	1	0	0	1
The idea of each paragraph completed by appropriate supported sentences.	1	0	1	0	1	0	1	0	1	0	0	1	1	0	1	1	1	1	1	1	1	1	1	
The idea of paragraph completed by adequate supported sentences (min. 2 sentences).	1	0	0	0	1	0	1	0	1	0	1	0	1	1	1	0	1	0	0	1	1	0	1	1
There is enough number of citation	1	1	1	0	1	1	0	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	0	1
The citation is writed by using varied style	1	1	1	1	0	1	0	1	0	1	0	0	0	1	0	1	0	1	1	1	0	0	0	0

The discontinuity ideas between paragraphs is crucial problem to resolve. Realizing coherence in written discourse is one major challenge confronting writers, since it is not just a desirable character of a text but a crucial aspect that establishes the oneness of a collection of abstract thoughts (Almaden, 2006). The discontinuity ideas between paragraphs was also analyzed through Indonesian language courses that had been followed by the research subjects. In the course, the material related to students' writing skills is *EYD* and *Composing Sentences*. From these two materials, students focus on understanding the use of words that are appropriate for *EYD* and how to compile sentences that are standard and in accordance with *EYD*. So that

research subjects still find it difficult to connect sentences between paragraphs. In addition, all subjects of the study were still unable to make paragraphs with the number of sentences or with ideal sentence proportions.

The discontinuity ideas between paragraphs of research is connected to subjects' mathematical thinking or mathematical logic. In mathematical logic, mathematics students especially at the university level are expected to be able to think deductively. According to Barkl, Porter, and Ginns (2012), deductive reasoning is a method of drawing conclusions from facts that we accept as true by using logic. The deductive reasoning means the ability to issue relevant ideas that are interrelated from general things to specific things to provide reinforcement on certain premises (Herbst, 2002; Hintikka, 2012; Park & Han, 2002; Watters & English, 1995). This is relevant to the ability to write ideas in scientific works that are connected to each other to provide reinforcement to certain theories/interpretations. The low ability of students to make paragraphs with connected ideas indicates the lack of deductive thinking skills of students. Furthermore, the correlation between writing skill and mathematics critical thinking according to research about explored the impact of WebQuest-based classroom on EFL learners' critical thinking and academic writing skills, revealed that both the WebQuest-based and the face-to-face classrooms developed the learners' critical thinking and academic writing skills, while the former outperformed the latter both in post- and delayed post-tests (i.e. short and long term effects) and took fewer sessions to cover the required materials. This can be a recommendation for learning mathematical logic (Ebadi & Rahimi, 2018).

The disadvantage of this study lies in the need for more information about the profile of the ability to research and write more varied characteristics. Six students as the research subjects actually have diverse characteristics. However, researchers feel that more information will be found if the number of research subjects is enlarged. Another disadvantage of this research is the short duration of the interview process, because most research subjects have become alumni. For further research, the interview process can be carried out longer and more intensively by asking the subjects to spend more time both online and offline.

CONCLUSION

Based on the results of data analysis, there are 2 conclusions in general. The consistency of the value of writing skills obtained by the subject, given by the researcher, appears from each item. But only researchers consistently produce excellent grades are very consistent. Whereas, subjects and items are consistent in the weak category. Initial profile of writing scientific work skills; The initial profile was obtained that the research skills of students (research subjects) were more dominant above the average, with dominant difficulties in paragraph formation.

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