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THE ANALYSIS ON STUDENTS' ERRORS IN SOLVING MATHEMATICAL WORD PROBLEMS OF CUBE AND BLOCK MATERIALS BASED ON THE STAGES OF NEWMAN'S ERROR ANALYSIS

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Abstract

This research objective is to analyze students' error in solving word problems by using the stages of Newman's Error Analysis. This research used descriptive qualitative. The subject of the research was 30 of 8th grade students of Madrasah Tsanawiyah Negeri Kampak Trenggalek academic year 2013/2014. Based on the finding, it could be concluded that: 1) At the reading stage, 8% students made errors. The difficulties faced by students were they could not interpret the sentences well. 2) At the stage of comprehension, 23% students made errors including not writing what was known, not writing what was asked in the questions, writing what was known but not accordance with the request of the questions, and did not know the meaning of the questions. 3) At the stage of transformation, 31% students made errors, namely students did not know the used formula, students miswrote the used formula, and students wrote uncompleted formula. 4) At the stage of process skills, 55% students made errors, namely errors in the process of counting for applying the used formula. 5) At the stage of encoding, 55% students made error errors, namely not writing the last answers or writing the last answers but not accordance with the context of questions. The causative factors were students did not comprehend the required questions, could not capture the information of problem contained inside the questions, they were less practice in doing various word problems and less rigorous.

Keywords: *error, mathematical word problems, Newman's Error Analysis*

INTRODUCTION

Word problem in mathematics lesson is a question presented in the form of descriptions or stories orally or in writing. Word problem is a modification of arithmetic questions related to the fact existing in students' environment (Haji, 1994). The form of word problem is daily verbal sentences of which the meaning of concepts and expressions can be expressed in mathematical symbols and relations. Understanding the meaning of concepts and expressions in word problem and turn it in mathematical symbols and relations into a mathematical model is not easy for some students.

The results of mathematics P4TK monitoring and Evaluation in 2007 and mathematics PPPG in previous years showed more than 50% of teachers stated that most students found difficulties in solving word problems (Raharjo, 2008).

The cause is students are less skilled in interpret daily sentences into mathematics. It is suspected that this occurrence deals with students do not have enough clear overview yet, especially on how to relate the real circumstances they encounter everyday with the related mathematical sentences. Perhaps also this happens since students are mentally less active involved in problem solving.

Word problem trains students to think analytically, train the ability to use the signs of arithmetic operations (addition, subtraction, multiplication, and division) and the principles or the formulas in geometry that have been studied. In addition, it also gives a practice in interpreting the stories of real-life situations into Indonesian. In line with this, Syamsudin (2003) stated that the practice of solving word problem is important for the development of process mathematically; appreciate mathematics as

a necessary tool in solving problems, and eventually students will be able to solve problems that are more complex.

The solution of word problem requires certain ability; this ability are viewed in the understanding of questions, which are the ability to write what is known from the question, what is asked in the question, what information is needed, and how to resolve the problem (Haji, 1994). Therefore, to determine how far students' ability in solving mathematical word problem it needs a tool to diagnose students' errors.

LITERATURE REVIEW

Newman's Error Analysis (NEA) was first introduced in 1977 by Anne Newman, a math teacher in Australia (White, 2010; White, 2010). Newman (1977, 1983) defined five special reading and counting skills essential to solve math word problems, namely reading, comprehension, transformation, process skills, and *encoding*. NEA provides a framework to consider the reasons underlying the students' difficulties in solving mathematical word problems as well as a process that helps teachers to determine where the misunderstanding occurs, also to provide guidance on how teachers can attempt the effective teaching strategies to solve them.

According to White (2005) after the students were given a math test about word problem, the next step teacher immediately gave an interview to the students. The NEA procedure, which is also used to guide the interview, is as follows:

1. To identify reading error: "Read the question to me. If you do not know a word tells me".
2. To identify comprehension error: "Tell me, what the questions asked you to do"
3. To identify transformation error: "Now tell me what method you used to find the answer"
4. To identify process skills error: "Now go over each step of your working, and tell me what you were thinking"
5. To identify encoding error or the inability to express an answer in an acceptable form: "Tell me, what is the answer to the question? Point to your answer".

However, when the students try to solve problems for the second time, and they can answer correctly, then that students' mistake will be classified as Careless.

An error will be classified as reading if students cannot read a single keyword or symbol written in mathematical word problems that they cannot continue the steps to acquire a proper problem solving. Errors will be classified as comprehension when students have been able to read all the words in the questions, but do not understand the whole meaning of the words; therefore, they cannot proceed further along the path of proper problem solving. Furthermore, the error will be classified as the transformation if students understand what is wanted in the question but they cannot identify the operation or the sequence of operations needed to solve the problem. Meanwhile, errors will be classified as process skills if students can identify the appropriate operation or the sequence of operations, but they do not know the necessary procedures to carry out those operations accurately. The last, error will be classified in encoding if students cannot write the final answer appropriately (White, 2005).

In the 1980s and 1990s the NEA had been introduced in Australia by Clements (1980, 1982, 1984) and in collaboration with Ellerton (eg, Clements & Ellerton, 1992, 1993, 1995; Ellerton & Clements, 1991, 1996, 1997) though there were others (eg, Casey, 1978; Clarkson, 1980; Watson, 1980; Tuck, 1983; Faulkner, 1992). NEA also widespread throughout Asia - Pacific region such as in Brunei (Mohidin, 1991); in India (Kaushil, Sajjin Singh & Clements, 1985); in Malaysia (Marinas & Clements, 1990; Clements & Ellerton, 1992; Sulaiman & Remorin, 1993); in Papua New Guinea (Clements, 1982; Clarkson, 1983, 1991); Singapore (Kaur, 1995); in the Philippines (Jimenez, 1992); and in Thailand (Singhatat, 1991;

Thongtawat, 1992), as well as in Indonesia (Muksar, 2009; Hanifah, 2009; Ali, 2011; Prasetyo, 2012; Bintari, 2013; Wahyuni, 2013)

Newman's research produces some evidences that students find more difficulties in semantic structures, vocabulary, and mathematical symbolism compared with standard algorithms. In several Newman research conducted in schools, the proportion of first error occurs at the stage of comprehension and transformation (Marinas & Clements, 1990; Ellerton & Clements, 1996; Singhatat, 1991), which is about 70 percent. These researchers also found that reading or decoding error contribute less than 5 percent of the initial error and it applies as well for process skills error, mostly related to the standard numerical operations (Ellerton & Clarkson, 1996).

On the other hand, the research conducted by Clements (1982) concluded that most errors made by students in solving word problems are at the stage of comprehension, transformation, process skills, and carelessness. Meanwhile, the research results of Parakitipong and Nakamura (2006) who analyzed 5th grade students' mathematical skills in Thailand concluded that students' most errors occur at the stage of comprehension and transformation, students who have a good ability tend to have a stronger understanding capability rather than students who have low ability. This is slightly different from research conducted by Bintari (2013) who acquired the results that students' most errors are at the stage of comprehension is 87.7%, while reading is 84,4%, transformation is 46.6%, encoding is 42.2%, and Process skills is 32.2%.

METHOD

This research used a qualitative approach and the type of research was descriptive. The subject of the research was the 8th grade students of Madrasah Tsanawiyah Negeri (MTsN) Kampak Trenggalek East Java, Indonesia amounted 30 students while the location of research also in MTsN Kampak Trenggalek East Java, Indonesia.

Data collection was conducted by using test and interview. Test was conducted to acquire data about the errors made by students based on the stages of Newman analysis. In this research test was arranged in the form of mathematical word problems on cube and block materials about five items. While the interview was conducted to acquire data in the form of words, which were spoken expressions about the errors made by students in understanding mathematical word problems. Interview conducted in this research was a structured interview using questions referred to five stages of Newman's Error Analysis. There were three students used as subjects of interview, each of them was taken from the group of students who had high, medium, and low abilities. Students were categorized in low-ability group if students' score was less than the lower quartile, students whose score was more than or equal to the lower quartile and less than the upper quartile were categorized into medium-ability group, while students whose score was more than or equal to the upper quartile were categorized into high-ability group.

Data analysis used in this research referred to the guidance of Newman's Error Analysis that included five stages: reading, comprehension, transformation, process skills, and encoding. Data acquired from this research were student answer sheets and interview results. Data, which were student answer sheets, were not only used to identify the types of students' errors but also used to determine the students who would be interviewed. While the data acquired from interview were used to identify the types of errors made by students in solving word problems based on the stages of Newman's Error Analysis.

DISCUSSION

Data acquired from the test results, which were written answer sheets, and the data acquired from interviews, which were interview transcripts, can be used to identify the types of students' errors.

Moreover, the types of students' errors in solving mathematical word problems on cube and block materials can be seen in Table 1.

Table 1. Types of students' Error

Students' Number	Types of Errors				
	Question 1	Question 2	Question 3	Question 4	Question 5
1	P,E	R,C	M	T,P,E	P,E
2	P,E	P	M	R,P,E	R,P,E
3	C,T,P,E	T,P,E	N	T,P,E	N
4	C,T,P,E	T,P,E	N	C,T,P,E	N
5	P,E	D	M	P,E	P,E
6	C,T,P,E	C,T,P,E	M	C,T,P,E	P,E
7	M	M	M	C,T,P,E	P,E
8	M	M	M	P,E	E
9	M	N	M	P,E	P,E
10	C,T,P,E	C,T,P,E	T,P,E	R,C,T,P,E	N
11	T,P,E	M	M	C,T,P,E	P,E
12	C,T,P,E	C,T,P,E	T,P,E	C,T,P,E	N
13	M	M	M	C,T,P,E	P,E
14	C,T,P,E	C,T,P,E	M	R,C,T,P,E	P,E
15	N	P,E	T,P,E	C,T,P,E	P,E
16	M	P,E	M	P,E	P,E
17	C,T,P,E	C,T,P,E	N	C,T,P,E	N
18	M	M	M	M	P,E
19	E	M	M	R,C,T,P,E	P,E
20	T,P,E	M	N	R,C,T,P,E	P,E
21	C,T,P,E	C,T,P,E	N	R,C,T,P,E	N
22	M	M	M	R,C,T,P,E	M
23	T,P,E	N	N	N	N
24	C,T,P,E	C,T,P,E	M	R,C,T,P,E	P,E
25	M	M	M	P,E	P,E
26	T,P,E	P,E	M	R,C,T,P,E	P,E
27	C,T,P,E	M	P,E	P,E	P,E
28	M	M	M	P,E	N
29	C,T,P	N	N	N	T,P,E
30	M	P,E	M	R,P,E	P,E

Notes: R = Reading Error
C = Comprehension Error
T = Transformation Error
P = Process skills Error
E = Encoding Error
N = Unanswered Questions
M = Difficulties not found

From Table 1 above, it can be seen that none of the students were able to answer all mathematical word problems given correctly. Table 1 above also shows that at the stage of *reading* in the first and third number of questions none of students made errors. While in the second number of question only one student (3%) made errors, in the fourth number of question ten students (33%) made errors and in the 5th number of question only one student (3%) made errors. In this reading stage, students can read fluently but they cannot interpret the sentences they read correctly. At the stage of comprehension, 11 students (37%) could not understand question number 1, eight students (27%) could not understand numbers 2, 16 students (53%) could not understand number 4, while none of the students found difficulties in question number 3 and 5. Most of them cannot understand what is known and asked in the questions well and do not know the steps in solving the problems. While at the stage of transformation for question number 1 there are 15 students (50%) made an error, question number 2 is nine students (30%) made an error, question number 3 is three students (10%) made an error, question number 4 there were 18 students (60%) made an error, and question number 5 only one student (3%) made an error. At this transformation stage, students cannot write the formula to solve mathematical word problems or students can write the formula, but it is not accordance with what it should be used in solving the problem. At process skills stage, there are 17 students (57%) made error in question number 1, 14 students (47%) made error in question number 2, only four students (13%) made error in number 3, 27 students (90%) made error in number 4, and 20 students (67%) made error in question number 5. It means that in this process, the students often make error in applying the formula written at transformation stage or the students cannot perform mathematical operations related to the formula used. Meanwhile, at the encoding stage there are 18 students (60%) made an error in question number 1, 13 students (43%) made an error in number 2, only four students (13%) made an error in number 3, 27 students (90%) made an error in number 4, 27 students (90%), and 21 students (70%) made an error in number 5. At this stage, many errors made by students are writing the wrong final answer as a result of errors at that stage, which are transformation and process skills, but there are also some students who forgot to write

down the final answer though they passed the process skills stage correctly.

Overall, the recapitulation of students' error percentage can be presented in table 2 below.

Table 2. Recapitulation of Students' Error Percentage

The stages of students' error	Percentage
Reading	8%
Comprehension	23%
Transformation	31%
Process Skills	55%
Encoding	55%

In Table 2, it can be seen that the largest proportion of errors made by the students is at the stage of process skills and encoding which is 55%. This occurs inasmuch as students do not know the procedures needed to carry out operation accurately even though they can identify the appropriate operation so that students cannot solve the word problems perfectly, it also affects the writing of the final answer which is incorrect. These errors made by students, especially in question number 4 and 5. Next is the transformation stage which is 31%, followed by comprehension stage which is 23%, and the last is the reading stage which is 8%.

The forms of students' errors at Reading stage are they cannot interpret the sentences they read correctly, even though they can read the math word problems smoothly as those are written in the Indonesian language which is already familiar to students. From interviews, reading errors occurred a lot in the question number 4, students cannot interpret the keyword "The length is twice its width" and "the depth is five more than the width".

The forms of student errors at comprehension stage is they have not been able to understand what is meant in the questions presented although they can read the questions well, because the question requires reasoning in understanding. From the results of tests and interviews, many students made comprehension errors in question number 1, 2, and 4. It is proven

from the students' errors in understanding questions no 1, students cannot understand the question "how many frame blocks that can be made?". Question number 2 students cannot understand what steps need to be done before determining the space diagonal of the chalk box if its volume is given. Meanwhile, question number 4 on the surface area of aquarium, most students identified the surface area of aquarium as the surface area of the block, whereas in reality the aquarium does not have a lid. Problem number 3 and 5 errors in understanding are relatively not found.

The forms of students' errors at transformation stage in this research is students were not able to identify the proper method to solve the given word problems. At this stage, there are 31% of students made errors, which are in question number 1, 2, 3, 4, and 5. The errors often made by students at this stage is the students do not write down the formula used to resolve problems or students write formulas used for misunderstanding the problems. Errors also occur when students transform the problems that had been read into a mathematical model. For example, in question number 1, some students who write the formula of the length of frame block as "p + l + t", while in number 2 some students who cannot write a formula to find the edge length and the space diagonal of cube if the volume is given. In question number 3, some students cannot write the formula to determine the edge length of cube cookie cutters and its volume if the surface area is given. Meanwhile, in question number 4 most students write the surface area of the aquarium as the surface area of the block, besides students cannot transform the sentence "the width of aquarium is 15 cm with the length is twice its width and the depth is five more than the width" into a mathematical model.

Process skills stage is a process in which students have skills to solve mathematics problems accurately. Error made by students based on this research is an error that should receive special attention from the teacher because mostly students do it. Students made error since

they cannot write the steps in solving problems. This error may occur since the comprehension and transformation stages so that they affect directly the stage of process skills. For example, in question number 4 only one student who can complete without facing difficulties. Question number 4, students' errors starts from writing the wrong formula so that the skill in the process of solving is inappropriate as well. Meanwhile, question number 5 most students can understand the question and are able to write a formula used accurately, but they cannot calculate the height of water surface in the first place after the volume of water is subtracted. After conducting interview and students told to solve that question again, some students can solve number 4 and 5 correctly. It proves that students are less rigorous in solving the first question; this is commonly referred to as carelessness. Question number 5 also only one student can solve perfectly.

At the stage of encoding, students' error occurred in writing the final answer. This stage is the last stage propounded by Newman. Students who make an error at this stage are 55%. Errors in writing final answer are closely related to the understanding and process skills. If both skills in previous are wrong, most likely at this stage they will also encounter errors. Most errors made by students are students do not write the final answer or students write the wrong final answer or students do not write the base unit used. Based on the test results of interviews conducted by the researchers, several students said that they often forget to write down the base unit used.

The causative factors from all errors made by students are students do not understand the question requested, students cannot catch the information of the problem existed in the question, students lack in practicing various word problems, students are less rigorous.

Overall, the results of this research showed that the largest proportion of students' error is at the process skills stage and encoding as well as comprehension, this research supports previous research

conducted by Clements (1982) who concluded that most errors made by students in solving word problems are at the stages of comprehension transformation, process skills, and carelessness. Reading error stage in this research only contributes 8%, it supports research conducted by Ellerton & Clarkson (1996) who found that *reading* or *decoding* errors contributed less than 5 percent of the initial error. Meanwhile, the results of the research conducted by Marinas & Clements (1990), Ellerton & Clements (1996) and Singhatat (1991) stated that students were facing difficulties in semantic structure, vocabulary, and mathematical symbolism compared with standard algorithms, the proportion of first error occurs at the stage of comprehension and transformation, which is about 70 percent. The results of this research is slightly different from the results of Bintari's research (2013) who found that the largest proportion of students' errors is at the stage of reading 84.4% and comprehension 87,%. Then, the results of research conducted by Hanifah (2009) stated that most errors made by students in solving word problems are at the stage of comprehension. Students cannot exceed Symbolic *Phase* based on theory propounded by Bruner (2008) the stage of learning where students have been able to represent the concept in the form of symbols, such as mathematical symbols and mathematical notation.

CLOSING

Conclusion

Based on the results of test and interview with students, the researchers concluded that the forms of students' errors viewed from the stages of Newman's Error Analysis (NEA) is as follows:

a. Reading Stage
    Students can read the question fluently because a given question is a word problem presented in the Indonesian and do not use difficult terms. Although students are fluent in reading, but most students cannot interpret yet what is intended by the

question that will lead to a different interpretation.

b. Comprehension Stage

Students' errors made at this stage are more prevalent because students find difficulty in changing the context of word problem language into mathematics language in which further will affect the problem-solving process. Within students' errors, students do not know what is meant by the question

c. Transformation Stage

At this stage, students often make errors because they misunderstand the question so that in transforming information from word problems they make errors; consequently, students mis-determine the method of solving these problems

d. Process skills Stage

At the stage of *process skills,* students make quite a lot of errors because they are less rigorous in the process of solving. It is influenced by errors at *comprehension* and *transformation* stages. In addition, it is also because students make carelessness.

e. Encoding Stage

Errors at this stage are: 1) writing down the final answer which is not in accordance with the context of the question, 2) do not write the final answer, and 3) do not write the base unit used.

Suggestion

This research only used the stages of Newman's Error Analysis; it did not include any modification as conducted by Clements (1982) by adding one more stage of error, which was *carelessness.* Therefore, for further research it is suggested to conduct student error analysis in solving mathematical word problems by using six stages, namely reading, comprehension, transformation, process skills, encoding, and carelessness, so that the proportion of students' carelessness will be revealed and teachers can undertake the efforts to reduce those careless errors.

REFERENCES

Ali, Muhammad F. 2011. *Analisis Kesalahan Penyelesaian Soal Cerita Matematika Berbahasa Inggris melalui Tahapan Analisis Kesalahan Newman pada Siswa RSBI SMP Laboratorium UM ,* Thesis is unpublished. FMIPA Universitas Negeri Malang.

Bintari, Bunga, Suci. 2013. Analisis Kesalahan Siswa dalam Menyelesaikan Soal Cerita Matematika Materi Sistem Persamaan Linier Dua Variabel Berdasarkan Tahapan Newman (Studi Kasus MAN Malang 2 Batu). Research is unpublished FMIPA Universitas Negeri Malang. Retrieved April, 15 2014 from http:// \web skripsi\analis-kesalahan-Newman.html.

Raharjo, Marsudi. 2008. *Pembelajaran Soal Cerita Berkait dengan Penjumlahan dan Pengurangan di SD.* Yogyakarta: P4TK Matematika.

Haji, Saleh. 1994. *Diagnosis Kesulitan Siswa dalam Menyelesaikan Soal Cerita di Kelas V SD Negeri Percobaan Surabaya.* Thesis of master degree is unpublished. PPs IKIP Surabaya.

Hanifah, Erni, H. 2009. *Identifikasi Kesalahan Siswa SMP dalam Menyelesaikan Soal Cerita Matematika Materi Sistem Persamaan Linier Dua Variabel Berdasarkan Metode Analisis Kesalahan Newman (Studi Kasus SMP Bina Bangsa).* Research is unpublished. IAIN Surabaya.

Casey, D. P. 1978. Failing students: a strategy of error analysis. In P. Costello (ed.). Aspects of Motivation (pp. 295-306). Melbourne: Mathematical Association of Victoria.

Clarkson, P. C. 1980. The Newman's Error Analysis- some extensions. In B.A. Foster (Ed.), Research in Mathematics Education in Australia 1980 (Vol. I, pp. 11-22). Hobart

Mathematics Education Research Group of Australia.

Clarkson, P. C. 1983. Types of errors made by Papua New Guinean students, Report No. 26. Lae: Papua New Guinea University of Technology Mathematics Education Centre.

Clarkson, P. C. 1991. Language comprehension errors: A further investigation. Mathematics Education Research Journal 3(2), 24-33.

Clements, M. A. 1980. Analysing children's errors on written mathematical tasks. Educational Studies in Mathematics, 11 (1), 1-21.

Clements, M. A. 1982. Careless errors made by sixth-grade children on written mathematical tasks. Journal for Research in Mathematics Education, 13(2), 136-144.

Clements, M. A. 1984. Language Factors in School Mathematics. In P. Costello, S. Ferguson, K. Slinn, M. Stephens, D. Trembath, & D. Williams (Eds.), Facets of Australian Mathematics Education (pp. 137-148), Australian Association of Mathematics Teachers, Adelaide, South Australia.

Clements, M. A. 2004. Analysing Errors Made by Pupils on Written Mathematics Tasks. Sultan Hassanal Bolkiah Institute of Education, Universiti Brunei Darussalam.

Clements, M. A., & Ellerton, N. F. 1992. Overemphasising process skills in school mathematics: Newman analysis data from five countries. In W. Geeslin & K. Graham (Eds.), Proceedings of the Sixteenth International Conference on the Psychology of Mathematics Education (Vol. 1, pp. 145-152). Durham, New Hampshire: International Group for the Psychology of Mathematics Education.

Clements, M. A., & Ellerton, N. F. 1993. The centrality of language factors in mathematics teaching and learning. Paper presented at the International Seminar on the Mathematical Sciences, MARA Institute, Kuching, Sarawak.

Clements, M. A., & Ellerton, N. F. 1995. Short-answer and multiple-choice pencil-and-paper tests: Still useful for school mathematics in the 21st century? Journal of Science and Mathematics Education in Southeast Asia, 18(2), 10-23.

Ellerton, N. F. & Clements, M. A. 1991. Mathematics in language: A review of language factors in mathematics learning. Australia: Deakin University Press.

Ellerton, N. F., & Clements, M. A. 1996. Newman's Error Analysis. A comparative study involving Year 7 students in Malaysia and Australia. In P. C. Clarkson (Ed.), Technology and mathematics education (pp. 186-193). Melbourne: Mathematics education Research Group of Australasia.

Ellerton, N. F., & Clements, M. A. 1997. Pencil and paper tests under the microscope. In F. Biddulph & K. Carr (Eds.), People in mathematics education (pp. 155-162). Waikato, NZ: Mathematics Education Research Group of Australasia.

Faulkner, R. 1992. Research on the number and type of calculation errors made by registered nurses in a major Melbourne teaching hospital. Unpublished M.Ed. research paper, Deakin University, Victoria, Australia.

Jiminez, E. C. 1992. A Cross-Lingual Study of Grade 3 and Grade 5 Filipino Children's Processing of Mathematical Word Problems, SEAMEO- RECSAM, Penang.

Kaur, B. 1995. A window to the problem solvers' difficulties. In A. Richards (Ed.), Forging Links and Integrating Resources (pp. 228-234).Darwin: Australian Association of Mathematics Teachers.

Kaushil, LD., Sajjin Singh, & Clements, M. A. 1985. Language Factors

Influencing the Learning of Mathematics in an English-Medium School in Delhi. Delhi: State Institute of Education (Roop Nagar).

Marinas, B., & Clements, M. A. 1990. Understanding the problem: A prerequisite to problem solving in mathematics. Journal of Science and Mathematics Education in South East Asia, 13(1), 14-20.

Mohidin, R. 1991. An Investigation Into the Difficulties Faced by the Students of Form 4 SMJA Secondary School in Transforming Short Mathematics Problems Into Algebraic Form. Penang: SEAMEO- RECSAM.

Muksar, Makbul dan Hasanah, Dahliatul 2009. *Peningkatan Kemampuan Bahasa Inggris dan Hasil Belajar Matematika Dasar 1 Mahasiswa Bilingual melalui Penerapan Metode Analisis Kesalahan Newmann,* Research is unpublished. FMIPA Universitas Negeri Malang.

Sulaiman, S., Remorin, P.R. (Eds.) 1993. Science- and Mathematics-related Project Work Abstracts of SEAMEO-RECSAM Participants. Penang SEAMEO RECSAM.

Newman, M. A. 1977. An Analysis of sixth-grade pupils' errors on written mathematical tasks. *Victorian Institute for Educational Research Bulletin,* 39, 31-43.

Newman, M. A. 1983. *Strategies for diagnosis and remediation.* Sydney: Harcourt, Brace Jovanovich.

Prasetyo 2012. *Analisis Perilaku Penyelesaian Masalah Soal Cerita Keliling dan Luas Lingkaran melalui Tahapan Analisis Kesalahan Newman pada Siswa Kelas IX H SMPN 2 Malang.* Research is unpublished. FP MIPA Universitas Negeri Malang.

Pratikipong,Natcha dan Nakamura, Satoshi 2006. Analysis of Mathematics Performance of Grade Five Students in Thailand Using Newman Procedure. CICE Hiroshima University, *Journal of International Cooperation in Education.*

Singhatat, N. 1991. *Analysis of Mathematics Errors of Lower Secondary Pupils in Solving Word Problems.* Penang: SEAMEO-RECSAM.

Thongtawat, N. 1992. Comparing the effectiveness of multiple-choice and short-answer paper-and-pencil Tests. Penang: SEAMEO-RECSAM.

Tuck, S. 1983. An investigation of the effectiveness of the Newman Language Mathematics Kit, unpublished M.Ed thesis, Monash University.

Wahyuni, Sri 2013. *Analisis Kesalahan dalam Menyelesaikan Soal Cerita pada Siswa dengan Gaya Kognitif Field Dependent Berdasarkan Tahapan Newman pada Materi Turunan Kelas Kelas XI IPS SMAN 6 Kota Jambi.* Retrieved April, 15 2014 from http:// \web skripsi\analis-kesalahan-Newman.html.

Watson, L 1980. Investigating errors of beginning mathematicians. Educational Studies in Mathematics, 11(3),319-329.

White, A. L. 2005. Active Mathematics In Classrooms: Finding Out Why Children Make Mistakes- And Then Doing Something To Help Them. *Square One,* 15(4), 15-19.

White, Allan, L. 2010. Numeracy, Literacy and Newman's Error Analysis. *Journal of Science and Mathematics Education in Southeast Asia,* Vol. 33 No. 2, 129 – 148.