The ability and analysis of Students' errors in the topic of algebraic expression

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Abstract. This study aimed to determine the level of ability of Form One students in the topic of algebraic expressions based on the six levels in the Bloom's Taxonomy Revision. In addition, this study aimed to identify the types of errors of form one students in the topic of algebraic expressions based on Newman's Error Analysis. Respondents of this study consist of 68 form one students were selected from school in Melaka through simple random sampling method. The data in this study has been analysed in a descriptive basis involving frequency, percentages and mean. This study uses the application of Statistical Package of Social Science (SPSS) version 26 for the purpose of this analysis. The findings showed that the students have troubled in the topic of algebra. 3 of 6 levels in the Bloom’s Taxonomy cannot be responded well by these students. Students only show high levels of mastery in the first two levels of remembering and understanding levels. Students have the most significant problems at evaluating level with the lowest percentage. The findings of this study also showed that most of students make an error in transformation. This study showed that error reading is lowest. In conclusion, these students have a problem answering the question of algebra and the type of common mistakes that are transformational problems. The implications of this study are, the Ministry and the teachers are able to makes reference to the difficult levels and the types of errors often made by form one students in the topic of algebra.

1. Introduction

The education system in Malaysia emphasizes the mastery of knowledge through mathematics subjects. The six core areas are knowledges, thinking skills, leadership skills, bilingual skills, ethics and spirituality and spiritual identity are outlined in the Malaysian Education Development Plan (MEDP). These features are essentials for every student, which is also in line with the National
Philosophy of Education (PoE). Among the assessments that Malaysia is involved in are the Program for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS).

Based on the results of these two international assessments, PISA and TIMSS in 2015, Malaysia is far behind Singapore. But to be fair, the country's position has actually improved especially in 2015 in the PISA and TIMSS results. The PISA is a 3-year international test covering 72 countries in 2015. TIMSS is the first 4-year international test conducted in 2015. The 2012 PISA results for Malaysia were alarming with 52 out of 65 participating countries. This has led to many perceptions of the quality of education in our country. In 2013 the government realized the problems that needed to be resolved immediately by taking various steps. Careful planning from the ministry led to the Malaysian Education Development Plan 2013-2025. In 2015 Malaysia climbed one step to 51 out of 72 countries. The PISA decision for 2018 will be finalized on December 3, 2019 and will determine whether the achievement has improved or not.

Trends in International Mathematics and Science Study (TIMSS) organized by International Association for the Evaluation of Education Achievement (IEA) also shows Malaysia's position in mathematics and science. The Malaysian students' achievement score is also left out of Singaporean students in all domains including the Algebra domain. How does two countries with the same of ethnicity and geographical position can produce students who are do far different from educational especially in mathematics? The results of Assessment TIMSS (2015) also saw an increase compared to the assessment before TIMSS (2011). For the subjects of mathematics, Malaysia was in the 22nd place with 465 points, up four stairs as compared to TIMSS 2011 with the 26th position (440 points) from 39 countries that took apart. However, this increase was still seen as a decline from the first year of Malaysia to participate in the assessment which was in 1999 because Malaysia's points dropped far below 2011.

Based on the analysis above, it is possible to see how countries like Singapore are more academically advanced than ours. However, Malaysia is now showing a slightly significant improvement and meaningful. Various efforts have been made by the government to change the curriculum from Kurikulum Bersepadu Sekolah Rendah (KBSR) to Kurikulum Standard Sekolah Rendah (KSSR) and from Kurikulum Bersepadu Sekolah Menengah (KBSM) to Kurikulum Standard Sekolah Menengah (KSSM). These efforts are crucial to keep Malaysia on the right track in education.

The algebra is one of the mathematical branches using letters and signs or symbol as representing figures and quantities. In Malaysia, the concept of algebra began to be taught in form one (Ministry of Education Malaysia, 2013). Algebra is considered as a gatekeeper which is a condition in many fields of education and employment [1]. In 2019, Sijil Pelajaran Malaysia (SPM) mathematics subject, many questions use algebraic expression topics as the basis for the answer to the final answer required. Therefore, it is important that this study be carried out to look at this algebraic domain more closely in terms of the level of ability of students and also the mistakes students often make. [2], in her study states that students do not master the basic concepts of Algebraic Expressions and this results cause the misconceptions in basic algebraic operations. Students make mistakes in certain aspects of Algebraic expressions such as simplifying algebraic fraction, factoring and expanding two expressions, [3]. All of these problems contribute to the students' lack of algebra skills. Most students find it difficult to grasp algebraic topics [4] [5]. This is supported by the [6], who found that student error in simplifying Algebraic expressions is not understanding the term concepts, implying mathematical law and creating rules of their own. Mistakes of concepts like these are often identified.

Therefore, this study seeks to identify the level of ability and type of error of form one students often commit in the subject of Algebraic Expressions.
a. Bloom’s Taxonomy

Anderson with her research team in 2001 have amended this six levels in terms of order and label level. They change by figuring each level should be a noun in order to reflect the cognitive process. According to [7], in the original Taxonomy, the Knowledge category includes both nouns and verbs. The name or aspect of the subject is stated in the vast subcategories of knowledge. Verbs aspect has been included in the definition given to the level of knowledge.

Students are expected to recall or recognize the knowledge. This leads to a level of Knowledge that has two properties and thus differs from the other taxonomic categories. This anomalies are eliminated in the revised taxonomy by allowing two facets, nouns and verbs, to form separate dimensions. The nouns is a foundation for the knowledge dimension and the verbs forms the basis for the dimension of the cognitive process. Therefore, this Bloom's Taxonomic Revision model was used for this study.

The revised Bloom's Taxonomy revisions are as follows:
1. Remembering: Obtain relevant knowledge from long-term memory.
2. Understanding: Define the meaning of teaching messages, including verbal, written, and graphical communication.
3. Applying: Perform or use a given procedure.
4. Analyzing: Break down the material into its constituent parts and trace how the parts relate to each other and to the overall structure or purpose.
5. Evaluating: Make judgments based on criteria and standards.
6. Creating: Putting elements together to form a novel, coherent whole or produce the original product.

b. Newman’s Error Analysis

Newman's error analysis model was first introduced in 1977 by Newman, a math teacher in Australia. In this model, Anne Newman proposes five basic steps as important to find out where the error occurred as the student solves the story-form problem. Five-step basic analysis of the Newman's error is reading, understanding, transformation, process and coding skills. [8], divided the five stages of Newman's error analysis into two. The problem-solving process has two types of obstacles that prevent students from receiving the right answers:
1. Problems in fluent linguistics and conceptual understanding that correspond to the level of easy reading and understanding of the meaning of problems, and;
2. Problems in mathematical processing consisting of transformations, process skills, and encoding of answers.

[9] concludes that the Newman Error Analysis (NEA) application in teaching can be a powerful diagnostic tool for assessing and analyzing students' difficulties in solving mathematical story problems. According to [10], each of these types of errors has an indication of identifying the type of error (Table 1).
2. **Methodology**

This study was conducted on 68 (20 boys and 48 girls) form one students at a daily secondary school in Malacca. Diagnostic tests 12 items in the topic of algebraic expression was conducted to determine students' ability in accordance with the Bloom Taxonomy Vision model. The question is divided into six sections. Two question represents each section. The parts are remembering, understanding, applying, analysing, evaluating and creating.

In addition, Newman's Error Analysis Model is also used to identify the type of error made when answering the question or solving the problem. There are five types of errors that are identified while reading the question, understanding question, process transformation, process error and error in writing the final answer. The interview was intended to serve as a supporting document for the findings of the study. Based on the diagnostic test, the respondents were interviewed with a number of questions to determine the cause of the error.

3. **Result**

3.1 **Level of Ability**

The Data obtained are analyzed with items by item. The correct answer for each Question is calculated in percentage. A total of 62 (91.18%) respondents answered Question 1 correctly. A total of 44 (64.71%) respondents answered Question 2 correctly. The average respondent correctly answered for the level of remembering was 77.90%. Question 3 and Question 4 are items for understanding level. There were 66 respondents of which 97.06% answered Question 3. A total of 64 respondents of 94.12% answered Question 4. The average respondents answered correctly for the understanding level was 95.60%.

The items for the application level were question 5 and question 6. There were 40 respondents of which 58.82% were able to answer question 5. A total of 38 respondents of 55.88% were able to
answer question 6. Average respondents were able to answer correctly for the applying level was 57.35%. Items for the analytical level were question 7 and Question 8. There were 34 respondents of which 50.00% were able to answer question 7. A total of 24 respondents of 35.29% were able to answer question 8. The average respondent can answer correctly for the level of analysing is 57.35%.

Next, the items for the evaluating level were question 9 and question 10. There were 10 respondents of 14.71% who answered question 9. A total of 6 respondents of 8.82% answered question 10. Only 16 respondents answered the items for the evaluating level. The average respondent correctly answered the rating level was 11.76%. question 11 and question 12 are the two items provided for the creating level. There were 14 respondents of which 20.59% were able to answer question 11. A total of 16 respondents of 23.53% were able to answer question 12. Only 25 respondents answered question 11 and question 12 which were two items for the creating level. The average response rate for the creating level was 22.06%.

3.2 Type of Errors

The data obtained is analyzed item by item. The type of error committed is calculated in percent. Table 2 shows the frequency of students who make the mistake of reading, understanding, transforming, processing and coding. From the analysis performed, no one made the mistake of reading.

| Reading          | Frequency | Percentage (%) | Mean  |
|------------------|-----------|----------------|-------|
| Question 0       | 0         | 0.00           | 0.00  |
| Understanding    |           |                |       |
| Question 1       | 2         | 2.94           |       |
| Question 2       | 12        | 17.65          |       |
| Question 3       | 1         | 1.47           |       |
| Question 4       | 1         | 1.47           |       |
| Transformation   |           |                |       |
| Question 5       | 9         | 13.24          |       |
| Question 6       | 4         | 5.88           |       |
| Question 7       | 1         | 1.47           |       |
| Question 8       | 11        | 156.18         |       |
| Question 9       | 15        | 22.06          |       |
| Question 10      | 6         | 8.82           |       |
| Question 11      | 1         | 1.47           |       |
| Question 12      | 2         | 2.94           |       |
| Processing       |           |                |       |
| Question 5       | 4         | 5.88           |       |
| Question 6       | 9         | 13.24          |       |
| Question 7       | 2         | 2.94           |       |
| Question 8       | 1         | 1.47           |       |
| Question 10      | 2         | 2.94           |       |
| Question 11      | 9         | 13.24          |       |
| Question 12      | 2         | 2.94           |       |
| Coding           |           |                |       |
| Question 4       | 1         | 1.47           |       |
| Question 5       | 1         | 1.47           |       |
| Question 6       | 2         | 2.94           |       |
In addition, Table 2 also shows the frequency of respondents making misunderstandings, transformational errors, processes and coding errors. The understanding errors occurred in Question 1, 2, 3 and 4 respectively, with frequency 2, 12, 1 and 1 respectively 2.94%, 17.65%, 1.47% and 1.47%, respectively. Transformational errors occurred in question 5, 6, 7, 8, 9, 10, 11 and 12 with frequencies 9, 4, 1, 11, 15, 6, 1, and 2, which were 13.24%, 5.88%, 1.47 %, 16.18%, 22.06%, 8.82%, 1.47% and 2.94%. Next, process errors occurred in question 5, 6, 7, 8, 10,11 and 12, respectively, with frequencies 4, 9, 2, 1, 2, 9 and 2 of 5.88%, 13.24%, 2.94%, 1.47%, 2.94%, 13.24% and 2.94%. Lastly is the frequency with which respondents make encoding errors. This error occurred in question 4, 5, 6, 7 and 8 respectively with 1, 1, 2, 4 and 2 respectively 1.47%, 1.47%, 2.94%, 5.88% and 2.94% respectively.

Table 3 shows the response results of each item. This table shows 420 of which 51.47% question answered correctly, 104 of which 12.75% question answered incorrectly and 292 of which 35.678% question was not answered by respondents.

Table 3. Response results of each item

| No. | Question | Correct | Incorrect | Not Answer | Total |
|-----|----------|---------|-----------|------------|-------|
| 1   | 62       | 2       | 4         | 68         |
| 2   | 44       | 12      | 12        | 68         |
| 3   | 66       | 1       | 1         | 68         |
| 4   | 66       | 2       | 0         | 68         |
| 5   | 40       | 14      | 14        | 68         |
| 6   | 38       | 15      | 15        | 68         |
| 7   | 34       | 7       | 27        | 68         |
| 8   | 24       | 14      | 30        | 68         |
| 9   | 10       | 15      | 43        | 68         |
| 10  | 6        | 8       | 54        | 68         |
| 11  | 14       | 10      | 44        | 68         |
| 12  | 16       | 4       | 48        | 68         |
| Total | 420     | 104     | 292       | 816        |

Percentage (%)  
51.47  
12.75  
35.78  
100

4. Discussion

The results of the survey have shown that 51.47% question got the right answer with the given diagnostic question. Whereas 12.75% question got the response they had already made various mistakes. There were also 35.78% of the total question Unanswered. The capabilities evaluated are divided into 6 sections according to the stages in the Bloom's Taxonomy Revision. From the analysis it was found that 130 out of 136 that 95.59% of respondents were able to master the level of understanding. This level is the most well-held level by the respondents. From the analysis it was also found that evaluating was the most difficult level with only 16 responses out of 39 of which 11.76% were able to answer correctly.
The errors committed are divided into 5 sections by type of error based on Newman's Error Analysis. From the analysis it was found that 47.12% of the respondents committed transformational error which saw a much higher percentage than other types of error. From the analysis it was also found that 0% of respondents made a reading error. Frequent errors are slightly different from previous studies. For example, studies by [11] stated that coding error was a frequent error of 68% compared to transformation error of 62% to second place. This means that although the findings of the study are different, it can be seen that the transformation error still shows a high percentage. Similarly, the study by [12], recorded the highest error rate of 89.33%, but the transformation error also recorded a high percentage of 54.67%.

5. Conclusion

This study has good implications for the ministry and also for teachers in Malaysia. Where it is seen is to help teachers identify the level of ability of their students based on the Bloom's Taxonomy Revision of the Algebraic Expression. Teachers can create a question that is more focused on the level they want to test. This study is a catalyst for teachers to try new techniques that can help students especially in difficult situations. Furthermore, it can also identify the types of errors students often make in answering algebraic expressions based on Newman's Error Analysis. This study shows that errors that are often made are transformational errors. Therefore, teachers will be able to help students to strengthen the transformation of pupils in answering question related to the topics of Algebraic Expressions.

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