Understanding the concept of fractions among mathematics trainee teachers*

Comprender el concepto de fracciones entre profesores en prácticas de matemáticas

Syed Azman Syed Ismail
Universiti Kebangsaan Malaysia - Malaysia
syed.azman@ipgm.edu.my

Siti Mistima Maat[1]
Universiti Kebangsaan Malaysia - Malaysia
sitimistima@ukm.edu.my

ABSTRACT

Students seem to have difficulty in fractions is an evidence of poor understanding or misconception. Understanding the concept of fraction is important for students to perform the procedure algorithm. Since teachers are the first-hand person by which students learn formal mathematics in our country, it is very important for teachers to identify the understanding of concepts and misconceptions about fractions to further improve conceptual understanding and overcome misunderstandings of the concept. Therefore, a study aimed to assess trainee teachers' levels of understanding in fundamental fraction knowledge was conducted. The participants in this study consisted of 23 trainee teachers that enrolled in a 4-years teacher education program in Mathematics major at Raja Melewar Teachers' Training Institute, Seremban. The instrument used in this study is Incorporating Fraction Knowledge Test, adapted from Chelsea Diagnostic Mathematics Tests. The findings show that the level of understanding of fraction among trainee teachers is at a moderate level. This implicated that there is a need for elevating trainee teachers' knowledge in fraction.

Keywords: fraction, trainee teachers, level of understanding.

RESUMEN

Los estudiantes parecen tener dificultades en las fracciones es una evidencia de una comprensión pobre o un concepto erróneo. Comprender el concepto de fracción es importante para que los estudiantes realicen el algoritmo de procedimiento. Dado que los maestros son la persona de primera mano por la cual los estudiantes aprenden matemáticas formales en nuestro país, es muy importante que los maestros identifiquen la comprensión de conceptos y conceptos erróneos sobre fracciones para mejorar aún más la comprensión conceptual y superar los malentendidos del concepto. Por lo tanto, se realizó un estudio destinado a evaluar los niveles de comprensión de los maestros en formación en el conocimiento de la fracción fundamental. Los participantes en este estudio consistieron en 23 maestros en formación que se inscribieron en un programa de educación docente de 4 años en la especialidad de Matemáticas en el Instituto de Capacitación de Maestros Raja Melewar, Seremban. El instrumento utilizado en este estudio es Incorporando Fraction Knowledge Test, adaptado de Chelsea Diagnostic Mathematics Tests. Los resultados muestran que el nivel de comprensión de la fracción entre los profesores en formación está en un nivel moderado. Esto implicaba que existe la necesidad de elevar el conocimiento de los profesores en prácticas en fracción.

Palabras clave: fracción, docentes en formación, nivel de comprensión.

*This research was funded by the grant PP-FPEND-2019 and GG-2019-065, Universiti Kebangsaan Malaysia.
1 Corresponding author. Faculty of Education, Universiti Kebangsaan Malaysia. harwati@ukm.edu.my

Recibido: 11/04/2019 Aceptado: 10/07/2019

INTRODUCTION

Fraction plays an important role in mathematics subject in primary school syllabus in Malaysia. Fraction is one of the topics in the Kurikulum Standard Sekolah Rendah (KSSR) syllabus taught to the students from Year 1 to Year 6. Fraction is a topic that needs to be mastered before learning ratios, proportions, decimals and percentages. Somehow, fraction is known as a critical component in mathematics subject (Rosli, Han, Capraro, & Capraro, 2013). Tests conducted by The National Assessment of Educational Progress (NAEP) against students show consistent results where students have a poor understanding of the concept of fractions (Sowder & Wearne, 2006). Melissa DeWolf et al. (2015) stated that students appear to have difficulty in fractions is an evidence of poor understanding or misconception. Understanding the concept of fraction is important for students to perform the procedure algorithm. Kerslake (1986) in his study stated that students often perform calculations without knowing the reason.

Understanding fractions concept occurs when students are able to relate the concepts and procedures as well as the relationship between words. In fact, students can develop an understanding of the concepts when they can make the relationship between the concepts and procedures (Fadzilah, 2012; National Research Council (NRC), 2001; Wong & Evans, 2007). According to NCTM (2000) all students should learn mathematical content and the process meaningfully with understanding.

It is known that teachers are the first-hand person by which students learn formal mathematics in our country, therefore teachers must be effective (Amran, Rahman & Surat 2018). According to Schoenfeld (2002) and Shulman (1986) a teacher must hold a profound understanding of mathematics that they teach. This statement was also supported by Baek et al. (2016) that to be effective, teachers have to understand the mathematical content of fractions other than computational procedures such as developing their pictorial representation for fraction and many others. Therefore, it is very important for teachers to identify the understanding of concepts and misconceptions about fractions to further improve conceptual understanding and overcome misunderstandings of the concept. Zhou et al. (2006) in his research, discovered that Chinese teachers achieved much better on the content knowledge of fraction in terms of concepts, computations and word problems and this is proven by the results of their student mathematics achievement. We are not going to discuss about Chinese teacher, but instead, we are focusing on pre-service teachers (trainee teachers) because previous research has consistently revealed that pre-service teachers were weak in their knowledge of fractions (Cramer, Post & del Mas, 2002; Davis & Thipkong, 1991; Tirosh, 2000). Chinnapan (2000) said that these trainee teachers having problems in explaining fractions to students and why the procedures work. This is because according to Becker and Lin (2005) even though the trainee teachers have a correct answer but they failed to carry out the procedures or strategies in the approved manner.

As a matter of fact, Marchionda (2006) reported that it is a teacher's job to be able to analyze (Nurshahira Alwani & Siti Mistima, 2016) these invented strategies to see where student's misconceptions lies (Halim, Yong, & Meerah, 2014) and to also determine the validity of the strategy. The students also may have a correct answer, but his method may not be correct. For that, a teacher should be able to understand the concept well enough to be able to explain to the students in various procedures (Mohankathan, Rosli, & Zakaria, 2019). The latest research was conducted by Baek et al. (2016) stated that trainee teachers are having difficulties in understanding fractions concepts and operations and this is leading to the misconception.

From all of the above, it is understood that a poor performance of trainee teachers at fraction can cause a serious problem to the students at school later on because they will be teaching mathematics in primary schools. It is very important that trainee teachers are equipped with the level of knowledge that meets the standards for their future quality and globally competed students (Mazlini & Effandi, 2012). Even though researchers have documented that trainee teachers are weak in their knowledge of fractions, little is known about trainee teachers' knowledge of fractions here in Malaysia. There are 27 campuses of Teachers' Training Institute producing over 1500 trainee teachers every year. It is essentially a significant issue and should be addressed in this research. Therefore, this study aimed to assess trainee teachers' fundamental fraction knowledge. The following questions directed the flow of this study:

1. How do trainee teachers perform in fractional mathematics knowledge according to the levels of understanding?
2. Do the trainee teachers perform equally between male and female in fractional knowledge according to the levels of understanding?
3. Do the trainee teachers that have undergone practical experience perform better than trainee teachers that have not undergone practical experience in fractional knowledge according to the levels of understanding?

METHODOLOGY

Participants

This study used a quantitative approach using test to collect data. All the participants were chosen using purposive random sampling technique. Participants consisted of 23 trainee teachers enrolled in a 4-years teacher education program in Matematics major at Raja Melewar Teachers' Training Institute, Seremban. These trainee teachers will require to take 5 credit hours in mathematics education, 35 professional education courses, and six months of practical at school (in a 3 phase) before entering primary school to teach mathematics. The participant details are as below:

Table 1. Participants involve in the research

Gender	Practical Experienced	No Practical Experience	Total
Male	6	4	10
Female	8	5	13
Total	14	9	23

Instruments

The instrument that used in this study is Incorporating Fraction Knowledge Test. It was a test of fraction concepts adapted from Chelsea Diagnostic Mathematics Tests (Kathleen Hart et al, 1985). The test consisted of 29 items and was specifically designed to measure the level of understanding in fraction knowledge. The instrument was then verified by two qualified Mathematics lecturer before administered to the participants. No items were eliminated. The criterions for Level of Understanding were modified since the participants are trainee teachers and the test level is for the primary school students. The reliability of the test was considered appropriate since, in the diagnostics test, the items are designed to be of different levels of difficulty and to test different aspects of the concept area. The test was also being used by the previous researcher twice with a large number of samples and the results are very consistent. This suggests that the test is reliable measures.

The areas covered in the test are related to concepts (meaning of fraction), equivalent fractions, ordering unit of fractions and addition, subtraction, multiplication and division of fraction. Item posed in the test such as "a, b and c are positive whole numbers. is less than when ..", "5 eggs in a box of 12 are found to be cracked. What fraction of the box of eggs is not cracked?", Fill in the missing number cased: .."

An instruction was given by researcher before the test was administered. Participants were given one hour to finish the test and were asked to show their work on the space provided in each item. General instructions for marking the test were given by the Chelsea Mathematics Diagnostic Test. There are certain codes given for marking the test. These codes can be used in future research for identifying common errors in fractions. There are several items that present certain levels of understanding. After all items were marked, researcher will then assign the students in each level of understanding. Percentage of participants were scored for each level. Below is the overview of the formulation of levels of understanding for all the items given in the test:

Table 2. Level of Understanding in Fraction Knowledge

Criterion	Level	Description
All correct of items 4(a), 4(b), 5(a), 5(b), 5(c), 7(b), 9(a), 9(c), 14, 16(a)	1	The meaning of fraction, seen as part of a whole, no equivalence needed. Equivalent fractions obtained by doubling. Addition of fractions with the same denominator
All correct of items 8, 9(d), 9(e), 10(a), 17, 19, 20, 21	2	Equivalent fractions not obtained by doubling. Using equivalence to name parts, with familiar fractions or when diagram provided. Ordering unit fractions.
All correct of items 10(b), 15, 16(b)	3	Questions where more than one operation is required; example: equivalence followed by addition or subtraction.
All correct of items 22, 23, 24, 26(a), 27	4	Division and multiplication of fractions. Generalisation.

RESULTS AND DISCUSSION

Trainee teachers' Levels of Understanding in Fraction Knowledge

Table 3. Levels of understanding achieved by trainee teachers

Level	Number of Respondents	Percentage
Level 1	21	91.3
Level 2	13	56.5
Level 3	16	69.6
Level 4	5	21.7

Table 3 shows the percentage of trainee teachers achieved according to each level of understanding. The highest percentage trainee teachers achieve is at Level 1 that is 91.3%. Only 21.7% of trainee teachers were able to achieved Level 4. This shows that the students are poor at generalization and have a low understanding when involving multiplication and division of fraction. Results also show that 56.5% of trainee teachers achieved at Level 2 which is lower if compares with Level 3 that is 69.6%. There are certain studies shows that trainee teachers always difficulty in understanding division of fraction because they font have ample knowledge about it (Unlu & Ertekin, 2012). Leung and Carbone (2013) stated that there is an inconsistency between trainee teachers' level of knowledge about fraction division and their actual knowledge.

Trainee teachers Level of Understanding in Fraction Knowledge between male and female

Table 4. Trainee teachers gender comparison achieved at Level 1

Level 1	Number of Respondents	Percentage
Male	10	100
Female	11	84.6

Table 5. Trainee teachers gender comparison achieved at Level 2

Level 2	Number of Respondents	Percentage
Male	6	60
Female	7	53.8

Table 6. Trainee teachers gender comparison achieved at Level 3

Level 3	Number of Respondents	Percentage
Male	8	80
Female	8	61.5

Table 7. Trainee teachers gender comparison achieved at Level 4

Level 4	Number of Respondents	Percentage
Male	3	30
Female	2	15.38

Table 4 shows the percentage achieved according to Level 1 among male and female trainee teachers. Female trainee teachers scored 15.4% lower than male trainee teachers. All male trainee teachers have answered all items correctly. 2 females' trainees' teacher have wrongly answer one question on the addition of fraction with the same denominator.

Percentage achieved according to Level 2 among male and female trainee teachers in Table 5 shows that male trainee teachers' percentage is the highest that is 60% compare to female trainee teachers scored 53.8%. The results show that some of the trainee teachers still having difficulties in understanding equivalent fraction and its ordering units. Gabriel et al. (2013) agree that most students have problems with equivalent fractions were not understood by the majority of children. This maybe because trainee teacher's mathematical knowledge is poor. This statement is supported by results in Turnuklu and Yesildere (2007) research that stated trainee teachers in their research have insufficient mathematical knowledge.

Table 6 shows that at Level 3 male trainee teachers' percentage is the highest that is 80% compare to female trainee teachers scored 61.5%. The female trainee teachers show that they have a poor understanding when it involves questions more than one operation. Male trainee teacher's percentage again is the highest that is 30% compare to female trainee teachers scored 15.38% at Level 4 as shown in Table 7. However, both gender achieved poorly in this level. Only five respondents were getting all five items correctly. As mention earlier, both having difficulties in questions that require them to generalize fraction.

Overall, this study shows that male trainee teachers achieved highly in each level compared to female trainee teachers. This contradicts with recent research stated that female does better than male in mathematics. In Bezina (2010) research, shows that female mathematics achievement is higher than male. There also research found that there is actually no gap among genders in mathematics. In fact, Hyde et al (2008) in his studies prove that there is no difference between male and female in mathematics performance. As a conclusion, we can say that maybe there are other factors that influence this to happen as according to Segal (2008) understanding or performance are swayed by cognitive as well as non-cognitive abilities such as motivation, effort and strive.

Trainee teachers Level of Understanding in Fraction Knowledge between practical experienced (PE) and no practical experience (NPE).

Table 8. Trainee teachers practical experience comparison achieved at Level 1

Level 1	Number of Respondents	Percentage
PE	14	100
NPE	7	77.7

Table 9. Trainee teachers practical experience comparison achieved at Level 2

Level 2	Number of Respondents	Percentage
PE	8	57.1
NPE	5	55.5

Table 10. Trainee teachers practical experience comparison achieved at Level 3

Level 3	Number of Respondents	Percentage
PE	10	71.4
NPE	6	66.7

Table 11. Trainee teachers practical experience comparison achieved at Level 4

Level 4	Number of Respondents	Percentage
PE	3	21.4
NPE	2	22.2

Table 8 shows the percentage achieved according to Level 1 among PE and NPE trainee teachers. 100 % of PE trainee teachers achieved Level 1 compared to NPE trainee teachers. All PE trainee teachers have answered all 10 items correctly in the Level 1. At Level 2 as shown in Table 9, 57.1 % of PE scored highest than NPE where only 55.5% NPE able to achieve that level. Table 10 shows that at Level 3 PE trainee teachers' percentage is the highest that is 71.4% of them compared to 66.7 of NPE trainee teachers. However, at Level 4, 22.2 % of NPE trainee teachers achieved that level compared to only 21.4% of PE as shown in Table 11.

Overall, this study shows that practically experienced trainee teachers achieved highly in each level except level 4 compared to no practical experience trainee teachers. This is because according to Shelby (2015) experienced teacher has this reasoning approach that students at school might use. Bayoud (2011) also stated that there is a significance difference between an experienced teacher and trainee teachers in all fraction operations. Trainee teachers that have gone for six months practical at school can be considered as "experienced trainee teachers" compare to trainee teachers that have not gone for practical at school. This "experienced trainee teachers" might have found quite a number of strategies to guide students at the school, thus they perform better in this test. Lin (2017) also supported that experienced teacher has more content knowledge compare to trainee teachers.

CONCLUSION

Based on these findings it can be concluded that the level of understanding of fraction among trainee teachers is at a moderate level. The study also reported that trainee teacher has difficulty in multiplication and division of fraction. Moreover, the results also showed that they have problems in ordering units of fraction. This implicated that there is a need for elevating trainee teachers in fraction knowledge. Therefore, mathematics department at teaching institute should create more pedagogical activities that have sufficient knowledge of basic concept such as fraction. The limitation of this study is the sample size. Researcher only used the respondents that enrolled in Raja Melewar Campus. If same research is conducted through all 27 campuses, and the results are the same, this will enhance the validity of the results

BIBLIOGRAPHIC REFERENCES

Amran, M, Rahman E., & Surat, S. (2018). Students' Emotions in Learning Mathematics : Contrasting Performance Perspectives, 10, 1411–1417.

Baek, J. M., Wickstrom, M. H., Tobias, J. M., Miller, A. L., Safak, E., Wessman-Enzinger, N. & Kirwan, J. V. (2017). Pre-service teachers' pictorial strategies for a multistep multiplicative fraction problem. The Journal of Mathematical Behavior, 45, 1–14.

Bayoud, J. M. (2011). A comparison of pre-service and experienced elementary teachers' pedagogical content knowledge (PCK) of common error patterns in fractions (Doctoral dissertation). Retrieved from https://books.google.com.my/books?id=bPUyMwEACAAJ&dq=A+Comparison+of+Preservice+and+Experienced+Elementary+Teach-

ers%27+Pedagogical+Content+Knowledge+(PCK)+of+Common+Error+Patterns+in+Fractions&hl=en&sa=X-&ved=0ahUKEwit3N-PtZfUAhXGJpQKHeUkCe0Q6AEIJzAA . American University of Beirut.

Becker, J. P. & Lin, C.Y. (2005). Effects of a computational skills workshop on preservice elementary teachers. Preliminary report. Paper presented at the Annual Meeting of the Mathematical Association of American and the American Mathematical Society, Atlanta, GA.

Bezzina, F. H. (2010). Investigating gender differences in mathematics performance and in self-regulated learning: An empirical study from Malta. Equality, Diversity and Inclusion: An International Journal, 29 (7), 669–693.

Chinnappan, M. (2000). Preservice teachers' understanding and representation of fractions in a JavaBars environment. Mathematics Education Research Journal, 12(3), 234–253.

Cramer, K., Post, T. R., & del Mas, R. C. (2002). Initial fraction learning by fourth and fifth-grade students: A comparison of the effects of using commercial curricula with the effects of using the Rational Number Project curriculum. Journal for Research in Mathematics Education, 33(2), 111–144.

Davis, E. J., & Thipkong, S. (1991). Preservice elementary teachers' misconceptions in interpreting and applying decimals. School Science and Mathematics, 91(3), 93–99.

DeWolf, M., Bassok, M., & Holyoak, K. J. (2015). Conceptual structure and the procedural affordances of rational numbers: Relational reasoning with fractions and decimals. Journal of Experimental Psychology: General, 144, 127–150.

Fadzilah Abdol Razak, N. N., Rohana Alias & Rohana Dollah. (2012). How do 13 -year olds in Malaysia compare fractions?. Procedia-Social and Behavioral Sciences, 42, 100–105.

Gabriel, F., Coché, F., Szucs, D., Carette, V., Rey, B. & Content, A. (2013). A componential view of children's difficulties in learning fractions. Frontiers Iin Psychology 4, 715.

Halim, L., Yong, T. K., & Meerah, T. S. M. (2014). Overcoming Students' Misconceptions on Forces in Equilibrium: An Action Research Study. *Creative Education*, *05*(11), 1032–1042. http://doi.org/10.4236/ce.2014.511117

Kerslake, D. (1986). Fractions: Children's strategies and errors. A report of the strategies and errors in secondary mathematics project. England: NFER-NELSON Publishing Company, Ltd.

Leung, I. K., & Carbone, R. E. (2013). Pre-service teachers' knowledge about fraction division reflected through problem posing. The Mathematics Educator, 14(1&2), 80–92.

Lin, J. W. (2017). A comparison of experienced and preservice elementary school teachers' content knowledge and pedagogical content knowledge about electric circuits. Eurasia Journal of Mathematics, Science and Technology Education 13(3).

Marchionda, H. (2006). Preservice teacher procedural and conceptual understanding of fractions and the effects of inquiry based learning on this understanding (Unpublished Doctoral Dissertation). Clemson University, South Carolina.

Mazlini Adnan & Effandi Zakaria. (2012). Pengetahuan konseptual pecahan dalam kalangan bakal guru Matematik. Jurnal Pendidikan Sains & Matematik Malaysia, 2(1).

Mohankathan, Rosli, R., & Zakaria, E. (2019). The Comparison of the Effectiveness of Conventional and Multimedia Approaches in Nurturing Student's Achievement towards Additional Mathematics. *International Journal of Academic Research in Business and Social Sciences*, 9(6), 774–778. http://doi.org/10.6007/IJARBSS/v9-i6/6064

National Council of Teachers of Mathematics (2000). Principles and standards for school mathematics Reston., VA: National Council of Teachers of Mathematics.

National Research Council. (2001). Adding it up: Helping children learn mathematics. Washington, DC: National Academy Press.

Nurshahira Alwani, M.T. & Siti Mistima, M. (2016). Perception of mathematics teachers on cooperative learning method in the 21st century. International Conference on Education, Mathematics and Science 2016 (ICEMS2016) in Conjunction with International Postgraduate Conference on Science and Mathematics 2016 (IPCSM2016)

Rosli, R., Han, S., Capraro, R. M., & Capraro, M. M. (2013). Exploring Preservice Teachers' Computational and Representational Knowledge of Content and Teaching Fractions. Research in Mathematical Education, 17(4), 221–241. http://doi.org/10.7468/jksmed.2013.17.4.221

Schoenfeld, A. H. (2002). Making mathematics work for all children: Issues of standards, testing, and equity. Educational Researcher, 31(1), 13–25.

Segal, Carmit. (2008). Motivation, test scores, and economic success (No. 1124). Department of Economics and Business, Universitat Pompeu Fabra.

Shelby P. Morge. (2015, November 9). Thoughts about conceptual fraction comparisons. Retrieved from - National Council of Teachers of Mathematics. http://www.nctm.org/Publications/Teaching-ChildrenMathematics/Blog/Thoughts-about-Conceptual-FractionComparisons/ [15 April 2017].

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15(2), 4–14.

Sowder, J., & Wearne, D. (2006). What do we know about eighth-grade student achievement? Mathematics Teaching in the Middle School, 11(6), 285–293.

Tirosh, D. (2000). Enhancing prospective teachers' knowledge of children's conceptions: the case of division of fractions. Journal for Research in Mathematics, 31(1), 5–25.

Unlu, M., & Ertekin, E. (2012). Why do pre-service teachers pose multiplication problems instead of division problems in fractions?. Procedia-Social and Behavioral Sciences, 46, 490–494.

Wong, M., & Evans, D. (2007). Students' conceptual understanding of equivalent fractions. J. Watson & K. Beswick Mathematics: Essential Research, Essential Practice, 2, 824–833.

Zhou, Z., Peverly, S. T., & Xin, T. (2006). Knowing and teaching fractions: A cross-cultural study of American and Chinese mathematics teachers. Contemporary Educational Psychology, 31(4), 438–457.