The ability of prospective teachers to pose contextual word problem about fractions addition

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Abstract. The low understanding of students on fractional topic has hampered the development of mathematics learning in Indonesia. This study was conducted to investigate in depth the ability of prospective teachers in developing the problem. Thirty four mathematics prospective teachers were asked to ask about contextual word problem whose solution could be obtained from counting \(\frac{4}{5}\) and \(\frac{2}{3}\). Data consists of a verbal protocol together with written notes made by the subjects. Qualitative analysis of the obtained data is focused on identifying the resulting problem structure and the type of context commonly used. The results showed that the most widely used contexts in the proposed story problem were the distribution of the cake, the weight of the object, the lots of the object, and the length of measurement. The structure of contextual problem produced by mathematicis prospective teacher has weaknesses in two components, namely: 1) in proposing appropriate contexts; and 2) in providing sufficient information so that the solution of the proposed problem can be obtained by applying the arithmetic concept of \(\frac{4}{5}\) plus \(\frac{2}{3}\). These results suggest new findings about prospective teacher difficulties in conceptualizing fractions.

1. Introduction

Student's weakness in understanding verbal tests has been a discussion in mathematical education research for over a decade. The form of student weakness is often associated with the term lack of literacy skills in mathematics. Especially in Indonesia, this can be seen from the test results PISA (Programme for International Student Assessment) 2015 which contains language literacy, math, and science literacy tests. In the last test Indonesia was ranked 69 out of 76 countries participating in PISA, down 5 ratings from previous period [1]. Though the ability to understand verbal problems is one of the main supporting factors in the achievement of curriculum competence in Indonesia.

Other Curriculum 2013 requires two core competencies that must be mastered by students related to mathematics subjects. The achievement of this competence requires a good understanding of students related to the story. While based on the results of initial research that researcher conducted on 237 junior high school students (2015) of 12 variants of the story given to students related to basic arithmetic on numbers, only 12% - 50% of students who are able to complete with the correct answer. In addition, many other studies have shown that one of the obstacles that students have in learning mathematics is their difficulty in understanding the story ([2], [3], [4], [5], [6], and [7]).
Various factors can be the cause of the weak ability of students in understanding the story. However, the cause is generally derived from two main sources, namely from the student self-related cognitive processes-and from their teacher. Student as cause factor can be shown through error analysis which often done by student in solving story problem ([8], [9], and [10]). While the teacher as the cause factor can be seen from how they are in presenting and understanding the story-shaped problem to the students.

The way the teacher in presenting the problems in the form of stories has been shown to directly affect the ability of students in understanding the story. This is closely related to the teacher's problems-solving ability. But the reality is that not all teachers can make a good filing. This is shown through several research results which conclude that the ability of teachers in raising problems in the form of stories is still very low ([11], [12], [13], and [14]). Whereas the ability to issue problems is one of the components in pedagogical content knowledge (PCK) that must be owned by a professional teacher. Problem posing is crucial in learning mathematics other than problem solving, which is a way to generate new problems from existing problems or situations - or those given [15]. This new problem-in the world of mathematics-can be presented in various situations. Such a composition was done already [16].

- Free problem posing situations. This situation is used when subjects are asked to raise issues based on "who" or "what", they will pose a problem.
- Semi-structured problem posing situations. This situation is used when subjects are given a situation that contains unfinished structures and is asked to explore issues related to the situation.
- Structured problem posing situations This situation is used when subjects are given a structured problem and asked to compose a new problem based on a given problem previously.

Several studies have also concluded that teachers who are experienced and have good knowledge of pedagogy have a positive effect on the level of student participation in the learning process [17]. To get this activity, the teacher must not ignore the relationship between mathematics content and the process. Students will more easily recognize the importance of mathematical content if the teacher does not neglect the relationship between content and process The teacher can train students' understanding of the relationship between content and process by using appropriate contexts. The use of appropriate contexts will help students understand the relationship between content and context so that it is easy to make mathematical representations and solve given problems. According to [18], ultimately the teachers are not able to develop word problems for those symbolic representations, the disability is considered as a factor responsible for the many failures in teaching mathematics [19]. Therefore, there is a need for in-depth investigation of the ability of teachers—and prospective teachers—in constructing stories as a contextual problem.

Students at every age can be successful users of mathematics (as a tool), can think mathematically and become good problem solvers, if they can learn mathematics comprehensively, apply mathematics, and can try to make meaning in collective and personal for what they have learned ([3], [20]). This can happen if they study the mathematics of the real-life situations that give them an in-depth context to construct their own mathematical knowledge.

Contextualization of problems in learning mathematics means explaining the problems in mathematics according to the specific situation in the daily life of students [21]. This is in line with the meaning of "context" when used in education can be viewed as matters relating to the learning environment. For students, the intended learning environment is home, community, and school. In this case the story takes a role to explain things related to the learning environment, while the context serves as the "meaning" giver for the students'.

One area where teachers show difficulties in asking a story is on fractional topic ([22], [23], and [24]). Fractions are theoretically important because the fractions require a deeper understanding of numbers than what students can get from integer learning experiences. In addition, the fractions are also important educationally of students because of their role in advanced mathematics. The fragile knowledge of fractional concepts at the time of primary school indicates low learning achievement in
algebra knowledge at the secondary school level, which generally controls almost all cognitive abilities [25]. Therefore, studying the concept of fractions into parts that cannot be separated from efforts to develop learning mathematics.

Based on the background of the above thinking, the researchers see the need for further research related to how the ability possessed by teachers or prospective math teachers in proposing problems in the form of a contextual story about the fractions. In this article the researcher focuses on the concept of addition of fractions. This study aims to: 1) know the context of the problem as what is generated by mathematics teacher candidate as a response from the request to propose a contextual story that the solution can be obtained by counting 4/5 plus 2/3; and 2) to know the structure of contextual story problems posed by mathematics teachers.

2. Method
The type of this research is semi-qualitative research with qualitative and quantitative approach. This explorative research is intended to reveal the ability of prospective teachers in the submission of mathematical problems. Submission of problems was to be done in the form of submission of contextual stories. Qualitative approach is used because this research meets the characteristics of a qualitative research [26]. While the quantitative approach is done by presenting the data generated in the form of diagrams and percentage.

2.1. Subject
Prospective teachers intended in this study are students of mathematics education who are still actively studying in college. The subjects are students of Mathematics Education Study Program of FKIP Halu Oleo Kendari University which is in semester VII academic year 2016/2017. Subjects in this study were selected by using two stages of sampling, the first performed stratified sampling and then carried out purposive sampling. In the first stage selected 34 students to take the test filing the problem. All subjects have gone through various lectures related to mathematics education and mathematics learning strategies. They are assumed to have studied the types of problems in mathematics, how to solve problems, and how to solve problems in the previous semester.

In the second sampling stage, 13 subjects of the volunteers were selected using sample techniques based on certain criteria [27] as one of the purposive sampling techniques [28]. This subject was then interviewed. The original name of each subject is kept secret which is then used a pseudonym for the elaboration of the research results. The "P" code is used for the interviewer.

2.2. Data collection
Data collection was done by giving Task Based Interview (TBI) to the research subject. TBI is done in two stages. In the first stage, subjects are assigned task A and task B through two sheets of tasks and given time to work independently for 60 minutes. At this stage, the first subject is asked to calculate the result from 4/5 + 2/3 and then create a contextual word problem whose solution can be derived from counting 4/5 plus 2/3. In the second stage, subjects are assigned task C and task D through a one-to-one interview with a duration of about 5 to 21 minutes. Subjects involved are asked to express the things they think verbally or nonverbally. During the second stage, the researcher performs audio recording, and avoids the intervention of the way the subject answers the question. At this stage the subject is interviewed about:

- Do you think that the question of the story you submitted is appropriate to the given problem situation?
- Why do you think that the solution of the problem you submitted has depicted 4/5 plus 2/3?
- How can you convince your students (later) that the solution of your problem is 4/5 plus 2/3?
- Did the problem you submitted match the context of the problem you selected?

2.3. Data Analysis
Data analysis in qualitative research is the process of searching and compiling systematically data obtained from interviews, field notes, and documentation, by organizing data into categories, describing into units, synthesizing, arranging into patterns, choosing which is important and that will be studied, and make conclusions so easily understood by yourself and others [28]. Based on this description, the data analysis process is done in three main steps, namely data reduction, display data, and conclusion drawing / verification [27]. At the data reduction stage, the subject matter generated by the subject is analyzed by its structure using the following rules.

### Table 1. Encoding contextual problems

| Structure | Note |
|-----------|------|
| B         | If the problem of loading a second-or any of these numbers (4/5 and 2/3), including both numbers can be derived explicitly from the proposed problem. |
| b         | If not B |
| C         | If the problem contains at least one of the 4/5 or 2/3 numbers, or this number can be derived explicitly from the proposed problem by appearing as a representation of a quantity measurement. |
| c         | If not C |
| K         | If the problem contains an appropriate link between the context and the 4/5, 2/3 numbers, and its operations |
| k         | If not K |
| P         | If the problem has a question where the answer is a "number" |
| p         | If not P |
| J         | If the answer to the problem can be obtained by using the information present on the problem |
| j         | If not J |
| F         | If the answer to the problem can be obtained by applying the arithmetic concept of 4/5 and 2/3 according to the given situation |
| f         | If not F |

2.4. Data triangulation

Triangulation is conducted to test the credibility of the data or trust in the data. There are several types of triangulation used in qualitative research. It is suggested three types of triangulation: (1) triangulation of data sources (triangulation by data source) which includes people, times, and places; (2) triangulation method (triangulation by method) includes observation, interview, documentation; (3) the triangulation of researchers (triangulation by researcher) includes investigators A, B, and so on [29]. This research was conducted on one data source by using data collection technique by observation, documentation, and interview. Therefore, triangulation used in this study is triangulation of data collection techniques.

3. Result

The completion of the fractional addition operation is performed in the same way by all subjects, ie by equating the denominator using the least common multiple (lcm) of 5 and 3. The procedure is a procedure that has been taught since elementary school.

Based on the interview results, it appears that Zoro understands the meaning of the addition of the fraction as well as its interpretation. Especially here they understand that 22/15 is a fraction greater than 1, while this is a mistake made by another subject. This is evident from the following statement: Zoro (02.34): “Well, because the denominators of the two fractions are not the same, then before adding up the two fractions, the Denominator of the two fractions is equated first by using lcm, because lcm of 5 and 3 is 15, then 4/5 = 12/15 and 2/3 = 10/15. the sum of the two fractions is done by adding up the two numerators. So, the sum of the two fractions is 22/15.”
Table 2. Example of contextual word problem (CWP) on the sum of fractions and its structures

| Label | CWP | Structure | Subject |
|-------|-----|-----------|---------|
| Weight Object I | Marni bought 4/5 kg of granulated sugar and 2/3 kg of brown sugar. How much sugar does Marni buy? | BCKPJF | Maria |
| Cake Division I | Ani has a square piece of cake, then Ani divides it into 4/5 parts. From 4/5 parts of Ani's cake, she divides it into 2/3 parts again. What is cake 2/3 part of 4/5 part of Ani's cake? | BCkPJF | Luffy |
| Cultivation of Rice | Mr Andi has a plot of paddy land covering an area of 4 km², the land will be planted with 5 different types of rice evenly. If it turns out that after one type of rice has been planted all died, and 2/3 of the other 4 types also died, then what is the area of rice that is still growing. | BCkPJf | Usop |
| Cake Division I | On the anniversary Ani made one cake that cut as much as 4/5 parts. The cake will then be distributed to Ani 3 friends. But because a friend is allergic to butter, then who get the cake from Ani only 2 people. How many of her friends got the piece of the cake? | BCkPJf | Nami |
| Band Length | Irma wants to replace the red and blue ribbon. The red tape requires 4/5 meters, while the blue ribbon requires 2/3 meters. How many parts are not replaced. | BCkpjf | Dyna |
| Cake Division III | Indah has a layer cake then will be cut into 4/5 parts. Then if 4/5 of that part is divided into 2/3, what is the amount of the piece of the cake? | BCKPjf | Ace |
| Proportion of Money | Mrs. Ati has as much as Rp. 30,000. Mrs. Ati went to the market to buy noodles and eggs with a total purchase of Rp. 24,000. Mrs. Ati has spent as much as 4/5 parts. Mrs. Ati then took out 2/3 of the money again. So how much money has been spent by Mrs. Ati? | BCkpjf | Rafli |
| Cake Division IV | Madan has 4 pieces of donut cake and 5 sponge cakes. Then Madan distributed the cake to Aldi each of 2 donuts and 3 sponge cakes. From the rest of the division, how many leftovers Madan sponge cake? | bckPJf | Badar |
| Lots of Marbles | Andi has 30 marbles. He plans to distribute the marbles to his two friends, Andri as much 4/5 parts and Andre 2/3 parts. How many marbles are Andri and Andre now does Andi have marbles enough to be shared with both his friend? | Kemal |

The result of task B shows that only 28 subjects are able to ask a story about the sum of the fractions. The following are examples of contextual stories produced by the subject and its structure.
There are 11 questions (39%) containing 4/5 and 2/3 as a quantity measurement with a quantitative question whose answer can be solved using 4/5 plus 2/3 and using the appropriate context (which has BCKPJF code). An example can be seen in Table 3 for the "Weight Object I" issue. After presenting 4/5 and 2/3 as the result of weight measurement, subject 17 presents the right question for a solution that can be obtained from 4/5 + 2/3.

Another problem that has the structure of BCKPJF, is the problem of "a lots of marbles". However, this problem has ambiguous code because in addition to loading two questions, the solution process should still use 4/5 + 2/3 although nor stated and unexplicity. The first question "What is the number of marbles of Andri and Andre now?" Is a quantitative question so it is coded P, but the answer can not be obtained from the information on the problem. As for the second question, "does Andi have enough marbles to share with his two friends?" Is not a quantitative question but the answer can be obtained from the information on the problem, and implicitly requires the reader to determine 4/5 + 2/3 before answer Yes or No. Therefore, this problem remains F code.

Only one CWP (3.57%) has coded BCKPJF that is the issue of "Number of Cakes". This problem is coded k because of the use of the word "4/5 seeds". The word "seed" is always identified with the quantity of objects that are discrete. Therefore, the use of this word results in the context used to be unsuitable for each interpreted fraction.

4. Discussion
Thirty-four mathematics prospective teachers were asked to propose four contextual story (CWP) questions whose solution could be obtained by counting 4/5 plus 2/3. The data obtained are 34 sheets of CWP submission and 3 audio recordings transcribed using verbal protocol together with notes made by the subject during the interview.

The researcher identifies the structure of the CWP created using the following criteria: 1) one or both of the given numbers (4/5 and 2/3), contained either explicitly or implicitly in the CWP formulation; 2) at least one of the given numbers is raised in the CWP formulation as a measurement of a quantity; 3) use the appropriate context for both the given number and the expected arithmetic operation; 4) the formulated CWP contains a quantitative question and has an answer that can be obtained using the information presented in the formulation; and 5) the solution of CWP is obtained by applying the arithmetic concept of 4/5 plus 2/3.

The most difficult criteria to be met by prospective teachers is the third and fifth criteria (46% - 58%). While the first, second, and fourth criteria can be met more than half (64% - 100%). Findings of more than 64% of prospective teachers who were able at several stages of the process of filing a problem to formulate a mathematically answerable question in accordance with the findings of several studies include [19], where in their study found that over 60% of teachers can do the same; and the invention of other study that about 80% of teachers can do the same. Although in his research, [19] did not ask teachers to propose specific concepts of mathematical operations, which does not agree with this study.

On the result, the fifth criterion is fulfilled by 57.14% (out of 25 people) prospective teachers. The disadvantage that exists in fractional sum operation is because the majority of subjects give false interpretations of fractional sums. Achievements that are still below 60% indicates a weak understanding of the concept of prospective teachers about the addition of fractions.

In the third criterion which concerned about the use of context, only 46.43% of potential teachers (who were able to apply related operations) were met. Context made by prospective teachers is generally a context related to itself and with friends around them during the task (first stage TBI). Very little is related to "who will solve the problem posed" (student), although the majority of prospective teachers interviewed claim that the problems they create in context are tailored to the needs of "students". This is in line with the finding of [30] when working in a group and asked to pose a problem, subjects tend to pose a context-appropriate problem to themselves and to members of the group.
Prospective teachers generally use context of cake distribution, weight of objects, measurement area, many objects, and length measurement in the proposed CWP. According to [31], the emergence of the majority use of these contexts is due to several reasons, including: the problem presented is a type of "traditional word problems" that reflects the subject's learning experience in elementary school; the chosen context is generally based on individual experience and interest including the subject's hobbies and personal preferences. In addition, contexts such as baking and weight distribution are the typical contexts used in primary and junior high school books ([33], and [32]).

Based on the results found there are several factors that cause the low ability of prospective teachers in proposing contextual stories related to the addition of fractions, namely:

- the prospective teachers focus only on the word given (which denotes the reduction), without thinking of the rationality of the problem they are proposing so as to produce problems that are sometimes unreasonable;
- prospective teachers forget the fact that something "added" to the fraction must come from the same entity (in accordance to [24]);
- prospective teachers focus on the facts of the sums that existed in the original numbers so that they produce problems that are not appropriate for the operation of the sum of the fractions, especially with regard to "baking" (in accordance to [24]).

Apart from described above, there are some weaknesses that are generally apparent in almost all of the story questions posed by prospective teachers. Those shortcomings are the use of "how many" oriented questions, not on "how proportion" or "what part" (such as the discovery of [33]) that should be a typical question on the story of fractions. Another disadvantage is that prospective teachers pose problems that are poor concepts of arithmetic fractions.

5. Conclusions

Based on the results of data analysis that refers to research questions can be summarized as follows.

1. The most widely used contexts in the proposed CWP are the distribution of cakes, weight of objects, and length measurements.
2. The CWP structure generated by the mathematics prospective teacher has weaknesses in two components: 1) propose appropriate context (code K); and 2) provide sufficient information so that the problem solution can be obtained by applying the arithmetic concept of $\frac{4}{5}$ and $\frac{2}{3}$ according to the given situation (code F).

Overall, researchers suggested further research on the ability of teachers and prospective teachers in proposing mathematical problems to reveal more about their own PCK. In addition, the researcher recommends to make problem solving as the focus of mathematics education research in Indonesia, both qualitative and quantitative.

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