# DEVELOPING A CODING SCHEME FOR EXAMINING PRE-SERVICE PRIMARY TEACHERS' SPECIALIZED KNOWLEDGE ON FRACTIONS DIVISION

Kamirsyah Wahyu[1], Sofyan Mahfudy[1], Afifurrahman[1], Ning Jauharotul Farida[2]

[1]Universitas Islam Negeri Mataram, [2]Institut Teknologi Bandung

Having a profound knowledge of fractions division (FD) is still a challenge for pre-service primary teachers (PTs). The current work aims to develop a coding scheme to examine PTs' specialized fractions division knowledge (SFDK). This coding scheme will be pivotal in unraveling the PTs' initial knowledge, such as their use of representations or errors when solving FD problems before designing instructional activities to develop the knowledge.

Two stages were carried out to develop the coding: (1) development and (2) testing, assessment, and refinement. The coding scheme was developed referring to the SFDK model (Wahyu, 2021) that represents connected and flexible knowledge of FD. Connected SFDK is the PTs' ability to move forth and back when using multiple representations in solving FD problems. Flexible SFDK is PTs' ability to differentiate each FD, which guides her/his movement across the representations.

PTs were given five tasks before being introduced to fractions division. For instance, *write a different word problem for 4÷2/3; 2/3÷4; 3/4÷1/2; and 1 2/3÷1/4!* (Task 4). There were 57 PTs' answers to the tasks and 10 answers were purposively selected for the coding to establish reliability. After five iterations of coding, discussion, and refinement, the coding scheme resulted in 7 categories and 36 codes. For example, category 6 (*symbolic-verbal*) has five codes (e.g., *correct answers-partitive*) to examine task 4. The percent agreement of three coders is over 0.7 and the $AC_1$ coefficient (Gwet, 2014) is greater than 0.7 for each category, both of which show a very good agreement.

## References

Gwet, K. L. (2014). *Handbook of inter-rater reliability: The definitive guide to measuring the extent of agreement among raters (4th ed.)*. Advanced Analytics, LLC.

Wahyu, K. (2021). Specialized fraction division knowledge: A proposed model. In M. Inprasitha, N. Changsri & N. Boonsena (Eds.), *Proceedings of PME44* (Vol. 4, pp. 212-220). PME.



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[1]*Universitas Islam Negeri Mataram,* [2]*Institut Teknologi Bandung*

## Introduction

- Many studies consistently reveal that (pre-service) teachers mostly do not have profound knowledge of fractions division (FD).
- Efforts to understand the teachers' knowledge and to support the development of such knowledge are very important.
- The development of a coding scheme as an analytical tool reported in this poster aims to understand pre-service primary teachers' (PTs) specialized fraction division knowledge (SFDK).
- This coding scheme will be pivotal in unraveling the PTs' initial knowledge, such as their use of representations or errors when solving FD problems before designing instructional activities to develop the knowledge.

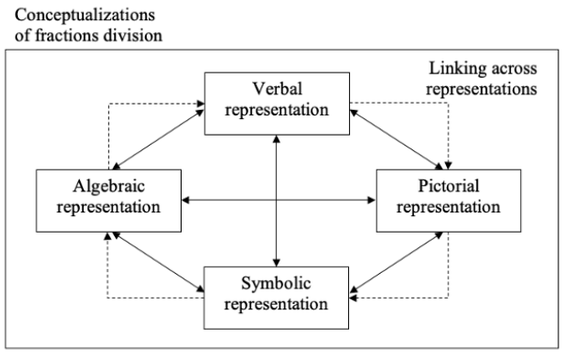


Fig. 1. The model of specialized fraction division knowledge

## Methods

- Two stages (Fig.2) were carried out to develop the coding
- PTs were given five tasks (See the sample task), designed to reveal the PTs' SFDK. There were 57 PTs' answers/responses to the tasks, ten answers (about 18%) were purposively selected for the coding process to establish reliability using percent agreement and Gwet's $AC_1$ coefficient (Gwet, 2014).
- After the coding training (three coders), five iterations of coding practices, discussions, and codebook refinement using the five different answers were carried out.

## SFDK model

- The coding scheme was developed referring to the SFDK model (Fig.1; Wahyu, 2021) that represents connected and flexible knowledge of FD.
- It is drawn from three conceptual bases: conceptualizations of fractions division, a representational system on fractions division, and specialized content knowledge.
- It explicates how the representations are linked in solving FD tasks and how different FD, either measurement, partitive, or unit rate, uniquely determines the process of linking the representations.

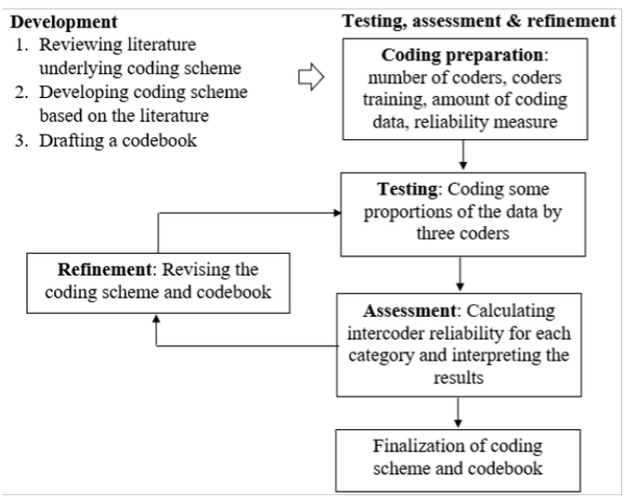


Fig 2. The flow of the coding scheme development

## Results

The coding scheme resulted in 7 categories and 36 codes (Table 1). The percent agreement of three coders is over 0.7 and the $AC_1$ coefficient (Gwet, 2014) is greater than 0.7 for each category, both of which show a very good agreement. Table 2 shows the sample of the developed codebook.

Table 1. Intercoder reliability of each category

| Categories | Agreement | Gwet's $AC_1$ |
|---|---|---|
| Verbal-Symbolic | 1.0 | 1.0 |
| Verbal-Symbolic-Reasoning | 0.81 | 0.75 |
| Verbal-Pictorial | 0.81 | 0.75 |
| Verbal-Algebraic | 0.99 | 0.99 |
| Algebraic-Pictorial | 1.0 | 1.0 |
| Symbolic-Verbal | 0.85 | 0.82 |
| Symbolic-Verbal-Reasoning | 0.81 | 0.73 |

Table 2. The excerpt of the developed codebook

| Category | Codes | Descriptions |
|---|---|---|
| **Verbal-Symbolic** | Correct answer | Determine a correct match between the word problem and number sentence |
| | Incorrect answer-fraction multiplication | Chose the number sentence of fraction multiplication |
| | Incorrect answer-reversed order of dividend and divisor | The dividend and divisor of the chosen number sentence is reversed |
| | Incorrect answer-mismatch | Mismatch the number sentence and word problem |
| | No answer | Do not answer |

## Conclusion

- The coding scheme is an important analytical tool to understand the complexity of the PTs' knowledge on fractions division.
- It is one of the efforts to unravel the PTs' difficulties and learning needs, then design learning interventions to develop their SFDK in the teacher education program.
- Several concerns emerge relating to the absence of all PTs' responses on task 3, the use of written data only, the instruction setting, and the independence of coders.

**A sample task**

Match the following word problems with the given number sentences! You may use one number sentence for more than one word problem.

(1) Dwi has 4 kg of flour to be put in a box. One box contains 2/3 kg of flour, how many boxes does she need?

(2) … (7)

**Number sentences**

(a) $\frac{3}{4} \div \frac{1}{2}$; (b) $\frac{2}{3} \div 4$ (c) $\frac{1}{2} \div \frac{3}{4}$; (d) $1\frac{2}{3} \div \frac{1}{4}$; (e) $4 \div \frac{2}{3}$; (f) $\frac{3}{4} \times \frac{1}{2}$; (g) $\frac{1}{4} \div 1\frac{2}{3}$

Explain why you choose the number sentence!

**References:**
Gwet, K. L. (2014). *Handbook of inter-rater reliability: The definitive guide to measuring the extent of agreement among raters (4th edition)*. Gaithersburg, MD: Advanced Analytics, LLC.
Wahyu, K. (2021). Specialized fraction division knowledge: A proposed model. In M. Inprasitha, N. Changsri & N. Boonsena (Eds.). *Proceedings of PME44*, Vol. 4, pp. 212-220. Khon Kaen, Thailand: PME.