



Identification of Difficulties in Teaching and Learning Fractions among Primary School Pupils: The Case of Third and Fourth Primary Levels

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ABSTRACT: In this study, we aim to identify the difficulties in teaching and learning the concept of “fractions” among third-primary (3rd grade) and fourth-primary (4th grade) learners in Morocco. We used a sample of 139 pupils (70 3rd-primary pupils, 69 4th-primary pupils) and 4 teachers.

We used a descriptive analytical methodology to treat the data collected through a supervised test (given to pupils) and a questionnaire (given to teachers). The results indicated that pupils in both third and fourth primary had major difficulties in recognizing fractions, representing them, and comparing them. Third-primary pupils had difficulties in associating fractions with their written form and in recognizing them visually from geometric figures. On the other hand, although fourth-primary pupils showed progress, they continued to have difficulties when comparing fractions with different denominators, particularly in tasks involving equivalent fractions. Teachers also noted a lack of depth in their teaching practices, which were often limited to theoretical approaches without sufficient links to concrete activities. These results suggest the need for a more interactive and hands-on teaching approach aimed at promoting visual and practical understanding of fractions to reinforce the acquisition of these essential concepts.

KEY WORDS: fractional numbers, 3rd grade, 4th grade, teaching, learning.

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1. INTRODUCTION AND RESEARCH PROBLEM

The main objective of education is to improve pupils' understanding and learning by providing them with knowledge and skills that enable them to solve a variety of situations and problems. Furthermore, fractions constitute a particularly complex mathematical concept, as they are based on several closely related meanings, which makes them difficult for pupils to learn (Charalambos & Pitta Pantazi, 2005). This complexity has been highlighted by several researchers who have proposed different ways of conceptualising fractions, describing them either as “interpretations” (Kieren, 1976) or as “sub-constructions” (Behr & al., 1983). They can represent the result of a division, a relationship between two quantities, or a part of a whole, which gives them several possible meanings (Lamon, 1999; Fandino, Pillia, 2005). Ni and Zhou (2005) referred to the ‘natural number bias,’ which refers to the difficulties pupils encounter when moving from whole numbers to rational numbers, while Rosar and al. (2001) showed that pupils often focus on the ‘how’ of procedures without grasping the underlying ‘why’. Indeed, many pupils confuse the numerator and the denominator and consider a fraction as two separate numbers rather than understanding it as a rational number expressing a single quantity or the sharing of a unit (Siegler, Fazio, Bailey, & Zhou, 2013). This flawed representation is also a source of numerous difficulties and errors in learning decimal numbers, which are nevertheless closely related to fractions.

Difficulties related to the teaching and learning of fractional numbers constitute one of the major obstacles encountered by pupils in primary school. These difficulties are not limited to an inability to perform the four basic operations (addition, subtraction, multiplication, and division), but rather stem primarily from an insufficient understanding of the concept of fractional numbers. This study aims to analyze the difficulties related to the teaching and learning of fractions among Moroccan primary school pupils,

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particularly at the third and fourth-primary levels. It seeks to examine how fractions are integrated into learning situations and to highlight teachers' perceptions and pedagogical practices. In this context, the following main research question guides the study: What are the learning difficulties related to the concept of fractions encountered by third and fourth-primary pupils in Moroccan primary schools?

2. CONCEPTUAL ELEMENTS

2.1. Fractional numbers

A fractional number is a rational number, generally expressed in the form of a quotient of two integers a/b (with $b \neq 0$), where a is the numerator and b the denominator. It may denote the result of a division or be expressed in decimal form (Grégoire & Meert, 2005). According to the Ministry of Education of Quebec, it can also be viewed as a ratio between two quantities and as a fractional representation of a rational number (MEQ, 1980, cited in El-Assadi, 2008, p. 29). The concept of fractions is multifaceted, which makes its learning particularly complex for pupils, as shown by several studies (Kieren, 1976; Brousseau & al., 2004; Grégoire & Meert, 2005).

Kieren (1976) distinguished several complementary dimensions:

1. Part-whole fraction: the fraction represents a part of a whole divided into equal parts, linking the numerator to the denominator. This is the foundational conception of fractions and the first introduced in primary education.
2. Ratio fraction: it expresses a comparison between two quantities, highlighting the relationship between pairs of numbers.
3. Quotient fraction: it corresponds to the result of a division, as in the sharing of objects or quantities.
4. Operator fraction: it acts as a multiplicative transformation applied to a number or a collection, producing a new proportional quantity.
5. Measure fraction: it represents the result of measuring through the iteration of a fractional unit, facilitating the understanding of fractions greater than one and the addition of fractions.

Thus, a fraction can be understood simultaneously as a part of a whole, a ratio, a quotient, an operator, or a measure, with each of these dimensions contributing to its comprehension and use across various contexts.

2.2. Objectives of the “Fractions” Unit at the third and fourth primary Levels

According to the Moroccan pedagogical guidelines (MEN, 2021), the introduction of the concept of fractions in primary education is carried out progressively. Pupils encounter fractions for the first time at the third-primary level through:

- Learning simple fractions and equal parts of a unit ($1/2$, $1/3$, $1/4$, $1/8$, etc.).
- Reading and writing fractions.
- Comparing and ordering fractions with the same denominator.
- Applying the addition of fractions to solve problems.

At the fourth-primary level, instruction progresses toward:

- Finding common denominators.
- Simplifying (reducing) fractions.
- Calculating sums and differences of fractions with identical or different denominators.
- Solving problems involving addition and subtraction operations.

3. RESEARCH DESIGN AND METHODOLOGY

To achieve the objectives of this study, we adopted a descriptive-analytical methodology, aimed at identifying the difficulties related to the concept of fractions among pupils at the third and fourth-primary levels.

3.1. Research sample

We worked with a sample of 139 pupils from the provincial region of Sidi Kacem, Morocco, including 70 third-grade primary pupils and 69 fourth-grade primary pupils. In addition, four teachers from both grade levels were interviewed to collect qualitative data on the difficulties encountered in the teaching and learning of the concept of fractions.

3.2. Measurement instrument

Data were collected using supervised tests administered to primary school pupils: a 3-item test for third-primary pupils and an 8-item test for fourth-primary pupils. In addition, a 10-item questionnaire was administered to primary teachers (appendix).

3.3. Data processing

The processing of the collected data was carried out using Microsoft Excel, which enabled the organization of the results.

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4. RESULTS

4.1. Analysis of teachers' results

The responses of the four teachers showed that they shared a common understanding of the concept of fractions. For them, a fraction was understood either as a part of a whole or as a ratio between two integers. They emphasized the need for pupils to master basic notions (particularly division, multiplication, and whole numbers) before addressing this concept. They also stressed the importance of moving between different semiotic representations (figural, verbal, and symbolic) to facilitate understanding. The teachers indicated that they introduced this concept through concrete situations drawn from everyday life (such as sharing a cake or a chocolate bar) to help pupils better grasp it. The relationship between fractions and decimal numbers was acknowledged by all teachers, mainly in contexts involving comparison or conversion. Nevertheless, while the use of the textbook was considered helpful, it was not deemed essential, as several teachers favored practical activities related to quantities, measurement, and pupils' real-life experiences.

The teachers reported that the main difficulties encountered by pupils concerned comparison, finding common denominators, and performing operations on fractions. These difficulties were attributed to weak foundational conceptual knowledge, limited instructional time devoted to this topic, and the infrequent use of fractions in everyday life. To address these issues, the teachers suggested using concrete situations, reinforcing foundational learning, and diversifying teaching methods. However, they acknowledged that some difficulties may persist, even though they tend to decrease when more active and contextualized instructional approaches are implemented.

4.2. Analysis of third-primary pupils' results by Item

 **Item 1** : Match each fraction with its written word form

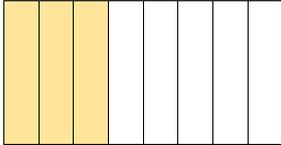
One third	One sixth	One half	One quarter	One fifth
$\frac{1}{2}$	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{1}{6}$	$\frac{1}{3}$

The results presented in Table 1 indicate that pupils were able to correctly identify fractions such as one fifth (81.4%) and one sixth (72.8%), whereas understanding of one half (45.7%) was lower. This difficulty may be explained by the complexity of the verbal vocabulary used, particularly in a context where French is not always the pupils' primary language. It can therefore be argued that language constitutes a significant linguistic barrier.

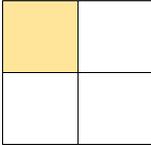
Table 1: Pupils' success rate in matching fractions with their written word forms

Fraction	Percentage of correct responses
One fifth (1/5)	81,4 %
One sixth (1/6)	72,8 %
One quarter (1/4)	72,8 %
One half (1/2)	45,7 %
One third (1/3)	62,8 %

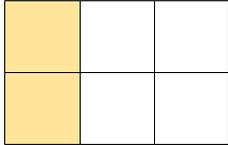
 **Item 2**: Write the fraction corresponding to the shaded part



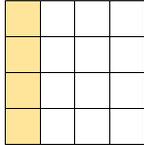
(a)



(b)



(c)



(d)

The results reveal an overall higher success rate, ranging from 74.3% to 78.6% (Table 2). This indicates that pupils have a relatively good understanding of the notion of "part of a whole" when it is presented in a visual and figural form.

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Table 2: Pupils' rate of correct responses when identifying the fraction corresponding to the shaded part

Figure	Shaded part	Corresponding fraction	Rate of correct responses (%)
(a)	3 out of 8 parts	3/8	77 %
(b)	1 out of 4 parts	1/4	78,6 %
(c)	2 out of 6 parts	2/6	78,6 %
(d)	4 out of 16 parts	4/16	74,3 %

Item 3: Compare fractions by using one of the symbols (<, =, >)

(a) : $\frac{3}{4} \dots \frac{5}{4}$, (b) : $\frac{1}{4} \dots \frac{1}{5}$, (c) : $\frac{4}{3} \dots 1$, (d) : $\frac{2}{2} \dots 1$

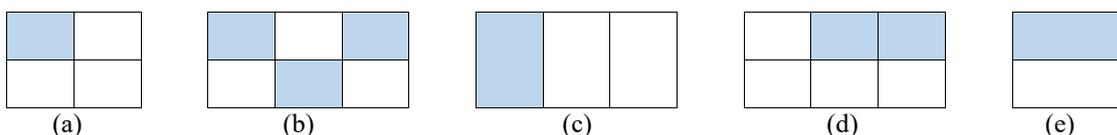
Table 3 indicates that the success rate ranges from 48.6% to 65.7%. The highest performance is observed in the comparison of fractions with the same denominator (e.g., 3/4 and 5/4), whereas more frequent errors occur when pupils are required to compare fractions greater than 1 (e.g., 5/4 or 4/3) or to interpret fractions equivalent to 1 (e.g., 2/2 = 1). In addition, some pupils confuse the symbols < and >, or show an incomplete understanding of the concept of equivalence between a fraction and the number 1 (e.g., 2/2 = 1). These results reveal a lack of mastery of procedures related to comparison and a partial understanding of the underlying fundamental concepts.

Table 3: Pupils' rate of correct responses in fraction comparison

Comparison cases	Rate of correct responses (%)
(a)	65,7 %
(b)	48,6 %
(c)	52,8 %
(d)	55,7 %

4.3. Analysis of fourth-primary pupils' results by item

Item 1 : Write the fraction corresponding to the colored part



The rates of correct responses are generally high across all the proposed figures: 95.6% for figure (a) corresponding to 1/4, 85.5% for figure (b) associated with 3/6, 84% for figure (c) related to 1/3, 85.5% for figure (d) corresponding to 2/6, and 91.3% for figure (e) associated with 1/2.

These results indicate that the majority of pupils clearly understand that the numerator represents the shaded part and the denominator represents the total number of equal parts. This performance is markedly better than that of third-primary pupils, who achieved an average success rate of 77%, reflecting a gradual assimilation of the concept of fractions.

Item 2: Write the fraction for the following figures

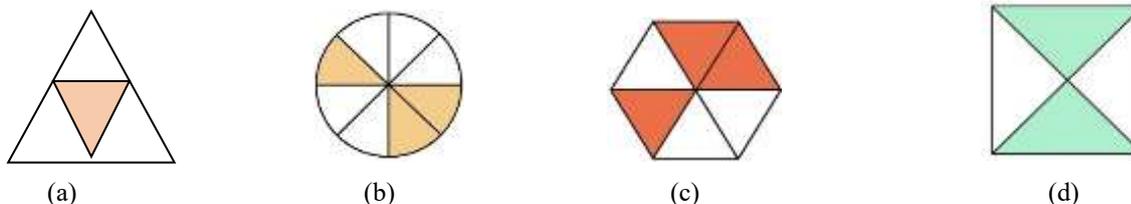


Figure (c) records the highest success rate (91.3%), followed by figures (b) and (d), which show identical rates of 86.9%. In contrast, figure (a) exhibits the lowest success rate, with 69.5% correct responses.

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These results highlight that the majority of pupils can represent a fractional number based on a given figure by identifying the part of the whole. Although some pupils experienced difficulties with figure (a), this may be attributed to a lack of concentration.

Item 3: Color the part represented by each fraction

$\frac{3}{8}$ $\frac{1}{4}$ $\frac{4}{6}$ $\frac{12}{16}$

The success rates for the shading task are very high for all the proposed fractions: 94.2% for fractions $\frac{3}{8}$ and $\frac{12}{16}$, and 95.6% for fractions $\frac{1}{4}$ and $\frac{4}{6}$.

These results indicate that most pupils have a good mastery of how to represent a fraction on figures. However, some errors were observed, mainly related to confusion between the numerator and the denominator.

Item 4: Write the lengths of the segments in fractional form

(a) (b) (c)

The rates of correct responses vary according to the proposed segments: 59.4% for segment (a) corresponding to the fraction $\frac{3}{5}$, 53.6% for segment (b) associated with $\frac{5}{6}$, and 57.9% for segment (c) related to $\frac{7}{10}$.

These relatively low rates indicate that pupils experience difficulties in understanding that the segment is divided into equal parts and that the numerator must be smaller than the denominator to represent a fraction less than 1.

Item 5: Identify fractions equivalent to $\frac{2}{5}$: $\frac{6}{15}$; $\frac{4}{10}$; $\frac{5}{11}$; $\frac{6}{13}$

The fraction $\frac{6}{13}$ records the highest rate of correct responses (66.6%), whereas the fraction $\frac{4}{10}$ shows the lowest rate (56.5%). The fractions $\frac{6}{15}$ and $\frac{5}{11}$ fall at intermediate levels, with 65.2% and 62.3% correct responses, respectively.

These results indicate that pupils experience difficulties in recognizing equivalent fractions and that the identification of relationships between fractions remains only partially mastered.

Item 6: Among the following fractions, circle the greatest fraction.

$\frac{116}{105}$ $\frac{112}{105}$, $\frac{12}{13}$, $\frac{10}{13}$, $\frac{1}{2}$, $\frac{3}{8}$, $\frac{3}{4}$, $\frac{5}{9}$

The comparison between the fractions $\frac{12}{13}$ and $\frac{10}{13}$ shows the highest success rate (91.3%), followed by the comparison between $\frac{116}{105}$ and $\frac{112}{105}$ (88.4%). In contrast, the comparisons $\frac{1}{2}$ – $\frac{3}{8}$ and $\frac{3}{4}$ – $\frac{5}{9}$ display markedly lower performance levels, with 60.8% and 53.6% correct responses, respectively.

The results show that pupils perform better when fractions share a common denominator. They also indicate that pupils experience difficulties when fractions do not have a simple multiplicative relationship between their denominators.

Item 7: Perform the following fraction operations:

$\frac{3}{4} + \frac{5}{4} = \dots\dots\dots$, $\frac{2}{3} + \frac{1}{4} = \dots\dots\dots$, $\frac{5}{3} - \frac{2}{3} = \dots\dots\dots$, $\frac{3}{2} - \frac{1}{5} = \dots\dots\dots$

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The addition of the fractions $\frac{3}{4}$ and $\frac{5}{4}$ shows the highest success rate (31.9%), whereas the subtraction $\frac{3}{2} - \frac{1}{5}$ records the lowest rate (17.4%). The operations $\frac{2}{3} + \frac{1}{4}$ and $\frac{5}{3} - \frac{2}{3}$ fall at intermediate levels, with 21.7% and 28.9% correct responses, respectively.

These low rates indicate that most pupils struggle to correctly apply addition and subtraction operations, particularly when finding a common denominator is required.

 **Item 8:** Problem (addition of fractions)

Fatima ate $\frac{2}{8}$ of the tart, while Ahmed ate $\frac{3}{8}$.

What fraction of the tart was eaten by both children?

The results indicate that 27.5% of the pupils were able to correctly calculate the fraction of the pie eaten by Fatima and Ahmed. Pupils were required to add the two given fractions, namely $\frac{2}{8} + \frac{3}{8} = \frac{5}{8}$, to determine the total portion consumed. These results show that approximately three quarters of the pupils experienced difficulties in identifying the essential information, selecting the correct operation, and applying fraction calculation techniques. It can therefore be argued that these obstacles were related to difficulties in understanding the French language and to insufficient mastery of fundamental concepts, particularly the implicit addition operation embedded in the problem statement.

5. DISCUSSION

This study highlights several key points related to the understanding of fractions among third fourth primary pupils in Moroccan primary schools. The results reveal significant gaps in the mastery of fundamental concepts and operations related to fractions. They also show that pupils experience difficulties in tasks involving the recognition, representation, and comparison of fractions. Moreover, the study identifies areas for improvement as well as the pedagogical challenges faced by teachers in teaching fraction-related concepts.

For third-primary pupils, the results indicate contrasting performance depending on the nature of the tasks proposed. Matching fractions with their written word forms reveals variable success rates, ranging from 45.7% for $\frac{1}{2}$ to 81.4% for $\frac{1}{5}$, while $\frac{2}{6}$ and $\frac{1}{4}$ reach 72.8%. This variability suggests that pupils do not yet have a stabilized understanding of the relationship between fractions and their verbal representations. These difficulties appear to be mainly related to insufficient mastery of fraction-specific vocabulary and a still partial understanding of their conceptual meaning. Previous research has shown that learning fractions relies on a long process of conceptual construction requiring concrete manipulations and varied situations before the appropriation of symbolic and verbal notation (Behr & al., 1983; Kieren, 1980). In addition, several studies emphasize that the linguistic naming of fractions constitutes a major cognitive obstacle for primary school pupils, particularly when instruction emphasizes memorization of terms rather than their grounding in sharing and measurement situations (Ni & Zhou, 2005; Siegler et al., 2011).

Identifying the fraction corresponding to a shaded part shows relatively high and homogeneous success rates, ranging from 74.3% to 78.6%. These results suggest that pupils can effectively mobilize figural representations to grasp the part-whole relationship. However, this success remains strongly dependent on visual support and does not guarantee a stable conceptual understanding of fractions. Indeed, numerous studies have shown that success in visual recognition tasks may mask deeper conceptual difficulties, particularly when pupils are required to use fractions outside an explicit figural context. Recent research indicates that pupils, as well as preservice teachers, may succeed in visual tasks while retaining a fragmented and non-integrated understanding of fractions (Švecová & al., 2022; Siegler & al., 2013).

In contrast, fraction comparison remains a particularly difficult skill to acquire, as evidenced by lower success rates ranging from 48.6% to 65.7%. The best performances are observed when the fractions to be compared share the same denominator (65.7%), a situation in which pupils can rely on whole-number-like reasoning. This difficulty is widely documented in the literature and can be explained by the need to master specific comparison rules (equivalence, common denominators, proportional reasoning), which often conflict with whole-number conceptions. Lamon (1999) thus identifies fraction comparison as one of the major obstacles in fraction learning, requiring a deep understanding of fractions as numbers rather than as mere sharing relations. These results show that third-primary pupils do not yet possess sufficiently stabilized conceptual prerequisites related to fractions. They reveal persistent difficulties in the appropriation of the fraction concept, linked to epistemological and representational obstacles, reflecting a still partial understanding of fractions as numbers, limited to certain representational registers and insufficiently coordinated across figural, symbolic, and numerical dimensions.

For fourth-primary pupils, the results show an overall improvement in performance compared to third-primary, while also revealing the persistence of differentiated difficulties depending on the nature of the tasks. Items related to identifying and writing fractions from figural representations (items 1, 2, and 3) show high success rates, generally above 85%, reaching 95.6% for some simple

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figures. These results indicate that most pupils can correctly establish the part–whole relationship by associating the numerator with the shaded quantity and the denominator with the total number of parts. This progress reflects greater familiarity among fourth-primary pupils with visual representations of fractions, which constitute an essential lever in the initial construction of the fraction concept.

However, a more detailed analysis shows that this success remains largely dependent on figural support. Certain graphical configurations, such as those proposed in Item 2 (Figure a), generate noticeably lower success rates, suggesting that despite apparent mastery, some pupils continue to rely on perceptual strategies rather than conceptual reasoning based on the equality of parts. These findings are consistent with recent studies showing that pupils may succeed in visual tasks without developing a stable and transferable conceptual understanding of fractional number (Behr & al., 1983; Siegler & al., 2011).

Difficulties become more pronounced in tasks involving a change of representational register, particularly writing fractions from segments (Item 4). The low success rates observed, ranging from 35.5% to 59.4%, indicate that many pupils struggle to conceive the segment as a measurable unit divisible into equal parts. This situation reveals a still fragile understanding of the joint role of the numerator and denominator, especially when the fraction is less than the unit. Recent research has shown that coordinating between linear and surface representations constitutes a major cognitive obstacle in fraction learning at the primary level (Lamon, 1999; Petit & al., 2010).

Furthermore, identifying equivalent fractions (Item 5) and comparing fractions (Item 6) remain problematic. Pupils perform better when fractions share a common denominator but encounter difficulties as soon as the underlying multiplicative relationships are not easily mobilized. These results confirm that understanding equivalence and fraction comparison relies on complex multiplicative reasoning that is still insufficiently mastered at this educational level (Ni & Zhou, 2005; Siegler & al., 2013).

Finally, fraction operations and the resolution problems involving the addition of fractions (items 7 and 8) constitute the most complex tasks. The very low success rates observed, particularly for the addition and subtraction of fractions with different denominators, reflect insufficient mastery of operational procedures and persistent difficulty in making sense of the operations performed. Several studies have shown that pupils tend to apply inappropriate rules, and struggle to make sense of fraction operations (Lamon, 1999; Siegler & al., 2013). Pothier and Sawada (1983) revealed that manipulating fractions with different denominators requires a thorough understanding of the relationships between fractions and more advanced calculation skills, which most pupils at this level have not yet mastered. These obstacles confirm that, despite notable progress, the conception of fractions as numbers remains incompletely stabilized among fourth-primary pupils.

In addition, the results reveal a shared understanding of the fraction concept among teachers, who view it both as a part of a whole and as a ratio between two integers. This conception is consistent with recognized didactic approaches and constitutes a favorable foundation for fraction teaching in Moroccan schools. Teachers observed that pupils tend to confuse fractions of the same value but different numerators and denominators, reinforcing the idea that a more systematic and visual approach to fractions is essential for success in such tasks (Cramer & al., 2002). A lack of familiarity with abstract comparisons may explain the decline in pupil performance in more complex situations, particularly when fractions do not share a common denominator. Regarding fraction instruction, it clearly appears that traditional approaches centered on textbook use are insufficient to overcome pupils' difficulties. Teachers participating in this study noted that practical and concrete activities, such as using cut-out fraction or visualizing fractions through geometric figures, yielded better results. This approach is also recommended by researchers in didactic of mathematics, who have emphasized the importance of visual representations in fraction teaching (Mack, 1990).

6. CONCLUSION

This study reveals persistent difficulties in the understanding of fractions among third and fourth-primary pupils in Moroccan primary schools, despite an overall progression in performance between the two levels. third-primary pupils exhibit a still fragile mastery of the links between the different representations of fractions, whereas fourth-primary pupils, although more successful in figural tasks, continue to encounter obstacles when activities require a change of representational register, fraction comparison, or operations on fractions, particularly those involving different denominators. Moreover, teachers share a generally sound conception of fractions, viewed both as part of a whole and as a ratio between two integers; however, they emphasize the limitations of traditional textbook-centered approaches and stress the need for pedagogical practices based on manipulation, the diversification of representations, and the gradual development of multiplicative reasoning in order to promote a deeper and more durable understanding of fractions from primary school onward.

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Appendix

Questionnaire

1. Define a fractional number.
2. In your opinion, which notions are necessary for introducing the concept of fractional number ?
3. What types of situations did you use to introduce fractional numbers?
4. Do you establish a link between decimal numbers and fractions? If so, at what stage of instruction?
5. Do you think it is relevant to introduce fractions through situations related to quantities and measurement? Why?
6. Do you consider the use of the textbook to be essential for promoting pupils' understanding of fractions?
7. In your view, what are the main difficulties encountered by pupils when learning fractions?
8. In your opinion, what are the causes or origins of these difficulties?
9. What activities or types of pedagogical situations do you propose to help pupils overcome these difficulties?
10. Do you think that, even after implementing these strategies, some difficulties would persist?