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# Teachers' views of practical work in the teaching of fractions: a case study

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*Teachers' views on practical work and their classroom practices were investigated to confirm or refute existing assumptions and literature claims. The teachers were from two primary schools in a rural area of the Hammarsdale Circuit in KwaZulu-Natal, South Africa. Questionnaires in which teachers expressed their views on practical work and fraction teaching were administered to teachers. Lessons on the division of fractions were observed to determine teachers' practices in relation to the researcher's assumptions and claims by literature. Data yielded by these research instruments confirmed assumptions and literature claims. Although this was a small-scale, qualitative study, interesting observations were made that could have pedagogical implications.*

**Keywords:** *division; fractions; practical work; teacher views; visual representations*

## Introduction

Informal observation of practices by mathematics teachers, coupled with informal interactions at experience-sharing forums, suggested teachers seldom include practical work when teaching fractions. This led to the formulation of the following research questions: (1) What are the views of teachers on practical work and the teaching of fractions and how do these views relate to their practices? (2) What are the factors behind these views? The study was conducted in two South African township schools.

A thorough understanding of the operations division and multiplication, with whole numbers, is a pre-requisite for understanding division of fractions (Flores, 2002). Learners' knowledge of working with whole numbers is a valuable reservoir to the learning of multiplication and division of fractions (Murray, Olivier & Human, 1996). There are different perspectives on fractions. Witherspoon (1993) citing Kennedy and Tipps viewed fractions as part-wholes, subsets, ratios, quotients and rational numbers. Instruction by most teachers still overemphasizes the part-region perspective of the fraction concept (Sinicrope & Mick, 1992; Witherspoon, 1993). Flores (2002) asserted that children go through several stages to develop the idea of the fraction in the context of subdividing areas. He advised that teachers need to make sure learners have developed a fairly complete understanding of fractions before discussing division of fractions.

Teachers who understand a topic make connections with other mathematical concepts and procedures (Flores, 2002). Flores suggested that some of the connections needed in the division of fractions are fractions and quotients, fractions and ratios, division as multiplicative comparison, reciprocals (inverse elements) and operators. Therefore teachers need to understand how the concepts of the fraction $\frac{3}{4}$, a quotient $3 \div 4$, and the ratio 3:4 are related to and different from each other. Limited exposure of learners to a single representation of the fraction concept has been identified to seriously impair learners' full development and understanding of the concepts of the fraction, and operations on fractions (Witherspoon, 1993). This includes the division of fractions. Subdivided regions for shading to indicate some fractional part of a real-life pizza, or a chocolate bar, are among some of the widely used examples for the fraction concept (Moskal & Magone, 2002; Witherspoon, 1993). This singular part-region representation of the fraction concept prevails (Witherspoon, 1993), although there are many other representations and interpretations which could improve the understanding of the fraction concept. To gain a complete understanding of the fraction concept, learners need to be exposed to a variety of concept representations. Witherspoon (1993) suggested the following five representations identified by Lesh *et al.* in 1987:

(a) symbols,
(b) concrete models,
(c) real-life situations,
(d) pictures, and
(e) spoken language.

A conceptual understanding of fractions and operations on them, as clearly distinct from the ability to successfully manipulate algorithms, is a necessary prerequisite if learners are expected to make sense of their learning about fractions. However, Flores (2002) argued that the division of fractions has been traditionally taught by emphasizing the algorithmic procedure 'invert the second fraction and multiply', with little effort to provide learners with an understanding of why it results in the correct answer. Witherspoon (1993) warned against assuming an understanding of fractions by learners merely because they are able to carry out an algorithm or recite a definition. In this light our view is that, to enhance the learners' understanding of fractions, there is a need for practical work which exposes them to different representations and models.

Among key principles that guide the development and implementation of C2005 and the follow-up RNCS, the education department's Policy Document listed: (a) participation and ownership, and (b) learner-oriented approach (DoE, 1997). The wording of these principles and other related ideals of Outcomes Based Education (OBE) suggest serious engagement of the learner in the learning process. To this end, Freudenthal (1991) and Gravemeijer (1994) accentuated the actual activity of doing mathematics; an activity, which they proposed should predominantly consist of organizing or mathematising subject matter taken from reality. Engaging learners with practical activities in learning fraction division provides more than ample opportunity for practical implementation of the ideals of OBE. Practical teaching of fractions by use of concrete models has been observed to be a difficult experience for teachers. Ott, Snook and Gibson (1991) argued that concrete experiences related to the division of fractions are much more difficult for teachers to devise and for learners to follow.



## Research methodology

The nature and quality of data generated by the questionnaires and observation of lessons, in response to research questions in the introduction, characterized the study as qualitative. Assumptions were made about the practices of teachers when teaching fractions and fraction division, and some of the underlying beliefs that inform these practices. The assumptions on which the study was based were:

(a) Minimal use of practical work by teachers is a source of impoverished development of concepts on fractions and operations on them, including division.
(b) Limited visual representation of the fraction concept with pictures of part-regions.
(c) Overemphasis of the algorithm as a goal of instruction.

These assumptions needed to be tested. To test assumptions on teachers' practices, lessons on fraction division were observed to ascertain the approach used by teachers. Twelve lessons of each teacher were observed. To find out more about the factors behind teachers' views on practical work in the teaching of fractions and fraction division, a questionnaire was designed for distribution among teachers. Schools that granted access gave three to four weeks within which to conduct the study. Therefore, this called for a compromise arrangement to generate reasonably credible data on teachers' perceptions of practical work, and the teaching of fractions and fraction division in relation to their practices. It was decided to administer the questionnaire to all four Grade 7 mathematics teachers in the two schools, but to observe only the lessons of one Grade 7 group per school.

## Observation

Patton (2002) explicitly listed observations among research instruments used in qualitative inquiries. To capture unfolding events in depth, a semi-structured type of observation was deemed as suitable. According to Cohen *et al.* (2000), a semi-structured observation has an agenda of issues of interest but gathers data in a far less pre-determined and systematic manner. This semi-structured character of the observation suited the qualitative nature of this study. The most appropriate role of an observer was observer-as-participant, who was known as a researcher to the group and had less extensive contact with the group (Cohen, Manion & Morris, 2000). Such a role allowed for the capture of events as they unfolded, with a special focus on what teachers did in relation to their assumed practices. The observer tape-recorded each lesson and made notes on teacher-learner interactions. For example, notes were made on

(a) whether practical work was used,
(b) the type of representations and models used,
(c) whether group work was used,
(d) the types of questions posed to learners, and
(e) whether sufficient time was allowed for learner responses.

## Questionnaires

Though questionnaires are predominantly associated with quantitative studies (Cohen, Manion & Morrison, 2000), if they make provision for open-ended responses, such questionnaires are capable of generating in-depth data on respondents' feelings, opinions, views, attitudes and perceptions about the phenomenon (the learning of fractions and fraction division by practical means). A questionnaire with all these attributes was designed as a research instrument for a qualitative study. These questionnaires were administered to teachers to find out their views on practical work and fraction learning. The questionnaire consisted mostly of closed items, eight items allowed for open-ended responses for teachers to express their opinions. This questionnaire tried to find a balance between a highly structured questionnaire (with closed items only) and an unstructured questionnaire (open-ended items) to find in-depth information about the role of practical work in learning fractions and subsequent fraction division. Prior to the actual fieldwork, the questionnaire was designed, piloted and refined. Inclusion of open-ended items was the product of these efforts. Teachers were given a week to complete the questionnaire.

## Results

### Teachers' views

*Is there a place for practical work on fractions?*

Four respondents answered the questionnaire. Data from questionnaires indicated that these teachers attached a strong value to the role of practical work in teaching fractions and fraction division. All four respondents agreed that fractions offered enough opportunities for the teaching and learning of mathematics through practical means. Their mostly preferred materials in teaching fractions and operations on them were:
(a) groups of objects — sets,
(b) pictures/diagrams, and
(c) worksheets [with tasks designed to promote practical work].

Two respondents preferred each of these materials. Paper-folding and the graded ruler were each preferred by only one respondent.

All four respondents strongly agreed that practical work has a place in the teaching of fractions (see Table 1). Respondents gave different reasons for their preference for models/aids that they used. The graded ruler, groups of similar objects (sets), and paper-folding were preferred because of their easy accessibility by learners. Sets and pictures/diagrams were chosen for their ease of use by learners. These teachers considered worksheets to be easy for learners to understand and answer. Other approaches were the number line (one respondent) and physical objects that learners could handle (three respondents).



**Table 1** The role of practical work in teaching fractions

| Statement | Strongly agree | Agree | Disagree | Strongly disagree |
|---|---|---|---|---|
| Practical work has a place in the teaching of fractions | 4 | 0 | 0 | 0 |

*Teacher claims about their practices*

While one respondent claimed to always include practical work in his lessons (including fractions), another indicated that he did it often and the remaining two sometimes. All respondents indicated they would definitely recommend the use of practical work in the teaching of fractions. Respondents gave different reasons why practical work seldom features in most teachers' lessons. Two respondents claimed practical work "*is time consuming*" — both during preparation and actual teaching. Another respondent cited lack of passion for the subject as a factor. Lack of resources and adequate training were suggested by one respondent. One respondent blamed overcrowded classrooms as another factor behind omission of practical activities from lessons.

*Are teachers adequately skilled for practical work?*

All four respondents claimed to have received formal pre-service training in practical work and the teaching of mathematics in general. Except for one respondent, all others agreed to materials development having been part of their pre-service training in practical work. The same respondent denied having ever received any form of training in the use of practical work for teaching fractions in particular. Two of the four respondents acknowledged having previously attended in-service courses on practical work in the teaching of fractions. The other two denied having had any such opportunities.

### Factors behind teachers' views

These teachers' favourable disposition towards practical work was informed by specific beliefs they held about practical work in the teaching of mathematics in general, and fractions in particular. Perhaps these views emanate from the OBE paradigm, which encourages the use of practical work. A number of external factors had a negative bearing on teachers' views.

*Understanding mathematical concepts*

All respondents strongly agreed that the main objective of any teaching session should be the understanding of mathematical concepts by learners rather than completion of the syllabus. However, in a related reinforcement item, one respondent felt that completion of the syllabus was equally important. This was the same teacher whose lessons did not include any practical activity. All respondents:

(a) disagreed that learning activities requiring learners to engage in practical activities were a waste of valuable teaching time,
(b) agreed that practical work fitted well with OBE requirements for a learner-centred approach,
(c) acknowledged the contribution of practical work to better understanding of fractions by learners, and
(d) agreed that learners could learn fractions better by handling physical objects (three of them strongly agreed).

However, their observed practices proved contradictory. These practices will be discussed in the following section. Although the teacher observed in school A showed a measure of commitment to practical work, his approach afforded learners little opportunity to explore practical work for their own benefit in the acquisition of concepts involved in fraction division. The teacher from school B showed complete devotion to rote learning. All these practices showed little or no evidence of espousing OBE's principles of:

(a) participation and ownership, and
(b) learner-oriented approach.

*External factors*

External factors included:

1. Large numbers in classes,
2. pressure to finish the syllabus, and
3. training in practical work.

1. Large numbers in classes

In response to why teachers seldom include practical work in their lessons, one respondent cited: "*Huge numbers in the classroom to work with*". In school A, the study was conducted with a class of 63 learners. This was before the group was split into the control group (33 learners) and experimental group (30 learners). The original size of the class confirmed the above claim by the respondent.

2. Pressure to finish the syllabus

Asked to choose the ideal primary objective of any teaching programme, one respondent indicated that finishing the syllabus and understanding of mathematical concepts by learners should both be objectives when teaching fractions. The respondent was the teacher from school B, whose observed lessons did not feature any practical work. This was the same teacher who thought that they (practical activities) were time-consuming.

3. Training in practical work

Except for one respondent, the other respondents had some training in the use of practical work in the teaching of fractions. This should be a strong factor behind the participants' favourable disposition to practical work (in theory), despite evidence to the contrary in these teachers' observed practices. So this raised the question of whether their training on use of practical work was enough. Perhaps it was only enough for them to see the benefit but not to know how to plan for practical work.



### Report on the observation of lessons of the two teachers

In school A, the teacher's approach to the teaching of fraction division embraced the use of visually abstract models. He did most of the work himself and did not allow learners enough opportunities to explore practical means to find solutions to given problems. The lesson was teacher-driven, since it was dominated by the teacher. This teacher used diagrams to demonstrate how the solution to problems, for example $2 \ni \frac{1}{3}$, could be found. Learners were not given sufficient time to use models. The teacher's final solutions contained errors. In some cases, the example used did not relate to division of fractions, which was the intended outcome of the lesson. After giving two definitions of division, i.e. sharing and grouping, the teacher wrote a fraction division problem $2 \ni \frac{1}{3}$ on the board and demonstrated the solution. The problem was not related to any real life situation. Only later did the teacher attempt to contextualize the problem, equating 2 to two cakes divided by $\frac{1}{3}$, although there was no explanation of what $\frac{1}{3}$ might represent. Figure 1 is an illustration of the teacher's solution.

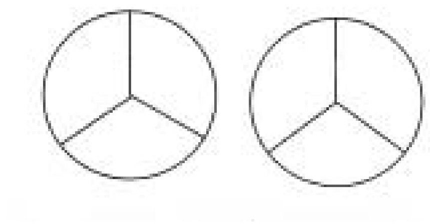

Figure 1 Teacher's circle solution of $2 \div \frac{1}{3}$

After depicting his solution, the teacher then asked learners how many pieces of $\frac{1}{3}$ were found in the 2 circles representing his two cakes. Learners correctly responded with 6. Erroneously, the teacher concluded and then wrote $\frac{6}{3} \mid 2$. This is equivalent to $6 \Delta \frac{1}{3} \mid 2$. The correct solution to the given problem would have been $2 \ni \frac{1}{3} \mid 6$. Figure 2 is an illustration of how the same teacher used the number line as an alternative approach to the solution.

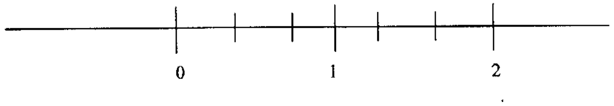


Figure 2 Teacher's number line solution of $2 \div \frac{1}{3}$

Again, the teacher erroneously concluded that the final solution was $\frac{6}{3} | 2$. In his two attempts at the solution, the teacher never explained how his final solution was related to the original problem. As his last example, the teacher demonstrated the solution to the problem 'find $\frac{1}{5}$ of $\frac{1}{2}$'. Figure 3 is an illustration of the teacher's solution.

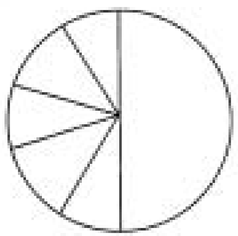

Figure 3 Teacher's circle solution to $\frac{1}{5}$ of $\frac{1}{2}$

After asking learners a number of leading questions, conclusion was finally reached that there were 10 fractions of $\frac{1}{5}$ in the two $\frac{1}{2}$ s, each of which is $\frac{1}{10}$ of the entire circle. Hence the conclusion that $\frac{1}{5}$ of $\frac{1}{2} | \frac{1}{10}$. This is not an example of a fraction division problem and was therefore irrelevant to the intended outcome of the lesson. The only visible involvement of learners during the lesson was their responses to the teacher's questions which probed desired cues towards the final solution.

In school B, the lesson on fraction division focused on the recalling of terminology and application of the algorithm, the origins of which learners were never assisted to understand, nor did they play any part in developing. The teacher wrote the following fraction division problems, (none of the questions was placed in a context) on the board:

$$(1)\ 6 \ni \frac{1}{2},\ (2)\ 4 \ni \frac{1}{2},\ (3)\ \frac{2}{3} \ni \frac{1}{6},\ (4)\ 2\frac{1}{2} \ni 5,\ (5)\ 1\frac{1}{2} \ni \frac{1}{4}$$

Using $\frac{1}{2}$ as a referent, the teacher revised the definitions of: (a) numerator and



(b) denominator. To revise reciprocals, the teacher asked learners to give reciprocals of $\frac{1}{2}$, $\frac{3}{4}$ and $\frac{5}{6}$, for which he wrote $\frac{1}{2} | \frac{2}{1}$, $\frac{3}{4} | \frac{4}{3}$ and $\frac{5}{6} | \frac{6}{5}$ on the board. Although this expression of learners' oral responses may have been understandable and perhaps acceptable within the context of giving reciprocals, the language of the symbols used suggested a different, incorrect and misleading story. In demonstrating the solution to problem (1), the teacher suggested awareness on his part of learners' prior knowledge of the fraction division algorithm, since he opened with the statement:

> "*We all know that when we divide with a fraction we change the divisor into its reciprocal and multiply the dividend with the reciprocal instead of dividing with the original fraction.*"

Although this was the first lesson on the division of fractions, note this teacher's use of the words "*We all know that* ". It seemed that this was a type of comment the teacher used by force of habit. Through leading questions, the teacher demonstrated the application of the division algorithm to the solution of the problem. When learners demonstrated solutions to subsequent problems, emphasis was also on reciprocals and accuracy in multiplication.

The next lesson dealt mainly with the division of mixed numbers. Here too focus was mainly on accurate reciprocals, conversion from mixed numbers and correct products. All these distinctive features of rote learning evident in this teacher's lessons were reminiscent of Siebert's (2002) parallels between operations involving fractions and seemingly nonsensical algorithms.

## Discussion

### Teacher's views

#### *Real practices against teachers' claims*

While the teacher from school A displayed a degree of commitment to the use of practical work in fraction division problems, the value of his efforts was seriously compromised by the erroneous conclusions he arrived at. However, data from this observation confirmed a number of claims made in the questionnaire. The teacher had claimed to often include practical work in his lessons, and he had used it in his demonstrations. This teacher perceived the use of models in a demonstration by the teacher as "*practical work*". The number line and pictures/diagrams, which he used in his demonstrations, were included among his preferred aids in the teaching of fractions and operations on them. Others were sets, the ruler, worksheets, and physical objects that learners could handle. The restriction of the aids used to the number line and diagrams, when his range of preferences had been so wide, could perhaps be associated with his justification for limited inclusion of practical work in mathematics lessons: "*Lack of resources and training*". The erroneous conclusions reached by the same teacher in his solution of fraction division problems were also cause for concern. Although he had agreed to having received training in using practical work in mathematics (including materials development), he denied ever attending an in-service course on practical work in the teaching of fractions.

Practices observed from the teacher in school B contradicted all claims made in the questionnaire. The teacher claimed having received pre-service and in-service training on practical work in the teaching of fractions. The ruler, sets, pictures/diagrams, and physical objects learners could handle were among his preferred materials. Easy accessibility was why he preferred most materials. Yet in spite of all these positive responses in favour of practical work, only evidence of rote learning of the algorithm by learners emerged from the observation of his lessons on fraction division. Perhaps an explanation for all these contradictions was summed up in his justification of the exclusion of practical work from mathematics lessons: "*They are time consuming*". *They* referred to practical activities.

A major finding was the contradiction between what the teachers said and their actual practice. Further, it appeared that these teachers were not using the problem-centred kind of approach recommended by the new curriculum. This requires not just to use 'practical materials' for fractions, but to choose real-world problems and contexts that can be used as starting points from which to develop the theoretical constructs, and ultimately some correct algorithms. Also for a problem-centred approach, learners (not the teacher) ought to first grapple with the problem and attempt to model it. The teacher should mainly be a facilitator to guide their learning and mental constructs in the right direction, but should also realize that there are several alternative methods and algorithms that learners can come up with.

*Teachers' plea for help*

All respondents were unanimous that engaging learners in practical activities fitted well with OBE requirements for a learner-centred approach and therefore felt OBE workshops in mathematics education should put more emphasis on practical work. Respondents wished to see more practical-work workshops on the teaching of fractions. Suggestions on areas such workshops should cover included:

- "*Development of materials because educators think it's expensive to find materials for practical work and it wastes a lot of time.*" (Teacher observed in school A.)
- "*Development of materials, easily accessible materials, learner activities, teacher's role during the lesson, assessment of practical work and lesson preparation to equip us (educators) with new developments.*" (Teacher observed in school B.)

The latter perhaps sums up the whole spectrum of developmental needs for a teacher whose lesson on fraction division begins and ends with memorization of the algorithm.

- "*Teachers need to be developed all the time since there are new things each day. Teachers should be developed on how to be innovative, competitive and also be life-long learners because they acquire new skills.*" (Another respondent from school A.)

The emphasis on developing teachers to be innovative and to be life-long learners supports some of the values that the new OBE dispensation intends to inculcate in the new breed of teachers that it envisages. It also encapsulates the motive for the common desire in all respondents for OBE workshops in mathematics to put special emphasis on practical work. Perhaps, if these workshops were to evoke in teachers qualities of innovation and being life-long learners, teachers would cease to think that *it's expensive to find material for practical work* [see first suggestion above]. Such workshops would perhaps also go a long way *in equipping us* (educators) *with new developments* [see third suggestion above].



*Teachers' difficulties in constructing practical fraction division activities*

The following are some of the reasons advanced for teachers' reluctance to include practical activities in their lessons:

(a) *They are time consuming.*
(b) *Maybe educators do not have love for mathematics. If they do have love they will be able to move from the abstract world of mathematics to the concrete world of mathematics.*
(c) *Lack of resources and training.*
(d) *Requires a lot of planning and preparation.*

The common message was that preparation of practical activities is a laborious exercise. With specific reference to the measurement and partitive/sharing interpretations of division, Ott, Snook and Gibson (1991:8) argued:

> Such concrete experiences are easy to devise and are relatively easy for students to follow as long as the numbers are whole numbers. However, meaningful concrete experiences related to division of fractions are much more difficult for teachers to devise and for learners to follow.

While failure of teaching to relate abstract concepts to learners' concrete experience is interpreted in response (b) as lack of passion for mathematics, it is insinuated in responses (a), (c) and d) that practical fraction teaching is a difficult task. These insinuations support the argument of Ott *et al.* (1991):

- The relevance of practical fraction division to OBE
  One of this study's motives was the relevance of practical work to OBE requirements for a learner-centred approach to teaching and learning. All respondents agreed that engaging learners in practical fraction division fitted well with OBE requirements for a learner-centred approach. Subsequently all respondents agreed that OBE workshops in mathematics should put more emphasis on practical work. In view of serious difficulties encountered by the implementation of OBE in schools, it is imperative for these workshops to pay attention to details that are informed by the genuine needs of teachers. It has been observed that "Workshops in OBE have not shed any light on educators because OBE facilitators have been unable to address educators' concerns" (Langa, 2003:65). It is such concerns that attention to detail by practical work workshops in fraction teaching should seek to address.
- Minimal use of practical work by teachers
  Although Ott *et al.* (1991) suggested that familiar concrete experience should be the first step in the development of new abstract concepts and

their symbolisation, they also acknowledged that this was hardly the case in the division of fractions. Their claims were confirmed by the observation of teachers' practices. In school A, while the teacher gave his learners severely limited experience with practical work, his efforts did not carry much weight as learners were not afforded any meaningful opportunities based on their own experiences in practical fraction division. This, coupled with erroneous conclusions the teacher arrived at in his demonstrated examples, resulted in learners not benefiting much from their experiences. In school B, all 12 of the observed lessons in fraction division were characterised by a complete absence of any practical activity in favour of absolute devotion to rote application of the fraction division algorithm.

- Limited visual representation of the fraction concept

  One of this study's assumptions was limited visual representation of the fraction concept with pictures of part-regions. The standard sub-divided regions for shading to indicate some required fractional part of a real life pizza have been cited and used by Witherspoon (1993) and Moskal and Magone (2002), respectively. The teacher from school A replaced the pizza with circles representing cakes (see Figure 1). His alternative, the number line, was still another representation of the part-region perspective of the fraction. These examples of the fraction perspective supported assumptions and claims of the restriction of the fraction concept to the part-region perspective. Dangers of the narrow view of the fraction as a part-region were highlighted by Witherspoon (1993) as: (a) the geometry of unmarked region models, and (b) application of knowledge of regions to other fraction interpretations. The negative effects of limited visual representation of the fraction concept on learners were evident in school A, even though learners had been exposed to demonstrations using drawings. This teacher did not use other visual representations, for example, real-life illustrations and concrete models, during the 12 lessons observed. One of the factors behind this overemphasis on the part-region perspective of the fraction concept is the over-concentrated focus of textbooks on this fraction perspective. It has been observed that "When it comes to fractions, it is not unusual for textbooks to emphasize the part-whole representations and fraction symbols, to the exclusion of other forms of expression" (Empson, 2002:35).

- Overemphasis of the algorithm as a goal of instruction

  Religious devotion to the algorithm by the teacher in school B was consistent with laments by Flores (2002) on overemphasising the algorithm procedure 'invert the second fraction and multiply', with little effort to provide learners with an understanding why it works. This also supported Siebert's (2002) assertion that children often lack a ready understanding for operations involving fractions because these operations are often equated with seemingly nonsensical algorithms, such as the fraction division algorithm. Practices in school B also supported observations by Sharp *et al.* (2002) that procedural knowledge, such as algorithms for operations, is often taught without context or concept, implying that algorithms are an ungrounded code only mastered through memorization. Fraser, Murray, Hayward and Erwin (2004) cautioned against the use of rote procedures and set rules in the learning of fractions. Further, Cramer & Bezuk (1991) and Witherspoon (1993) warned against assuming an understanding of fractions by learners merely on the basis of successful application of the algorithm.



## Factors behind teachers' views

### *Teachers' beliefs*

The underlying belief by all respondents to the questionnaire that learners' understanding of mathematical concepts should be the primary objective of instruction informed further beliefs that: (a) practical work fitted well with OBE requirements for a learner-centred approach to teaching, (b) learning activities that require learners to engage in practical work are not a waste of time, (c) practical work contributes to learners' better understanding of fractions, and (d) learners can learn fractions better by handling physical objects. Belief (a) has been discussed. Beliefs (b) to (d) support the assertions on the value of practical work in aiding learners' better understanding of fraction division (Flores, 2002; Siebert, 2002; Sinicrope *et al.*, 2002). Sinicrope *et al.* (2002) offered advice on examples for concrete experiences for learners by suggesting instrumental models, like pattern blocks, can be used for the measurement interpretation of fraction division. Siebert (2002) gave examples of how diagrams can be used to find solutions to fraction division problems.

### *Convenience, efficacy and expediency*

The convenience of practical activities to peculiar conditions, they may be faced with, was another determining factor behind teachers' views on practical work in fraction teaching. Large numbers in classes and pressure to complete the prescribed syllabus were cited among some of the conditions facing teachers, which determine the convenience and suitability of practical work in fraction teaching. The efficacy and expedience of various instruments of practical work were other factors behind teachers' positive disposition towards practical work. However, there was evidence of serious difficulties that teachers encounter when they consider implementation of practical work. These difficulties were manifestations of claims by Ott *et al.* (1991) on difficulties teachers encounter in their attempts to construct practical activities for learners. These were discussed in the previous section. Whitworth and Edwards (1969) offered a range of suggestions on instruments and activities for practical work in fraction teaching that teachers could find useful to address their difficulties.

### *Teachers' level of training*

Their level of training was another driving factor behind teachers' favourable disposition towards practical work. Yet in spite of their claims of adequate training in practical work in fraction teaching, teachers' observed fraction-teaching practices revealed half-measures and errors, or complete omission of practical work from their lessons on fraction division. These shortcomings in use of practical methods in fraction teaching, together with glaring errors made by the teacher in school A, call for the design of training programmes to assist teachers with their difficulties. Training should facilitate real skills in planning, and organising practical work with groups and not just an introduction to interesting activities.

## Conclusion

### Pre-service training

It has been observed that "pre-service mathematics teachers regard personal or formal theories of teaching and learning mathematics and classroom practice as separate areas of study" (Hobden, 1999:76). In this study, the observed contradiction between teachers' classroom practices and their self-declared positive attitudes towards practical fraction teaching looks like a continuation of Hobden's observed pre-service tendencies of trainee teachers to regard theory and practice as two separate entities.

Pre-service teacher training needs to take into account the teachers' reasons for excluding practical work and implementing teaching strategies that are not centred on practical work. Therefore, teacher training needs to provide programmes that directly address these concerns, especially issues of overcrowded classrooms and perceptions that practical activities take up a lot of time, both during preparation and implementation. The issue of overcrowded classrooms is still a thorn in the side of our public education system. Yet the approach of our teacher training programmes continues to tailor the training of teachers along methods that are suitable for normal-sized classes. The notion that practical activities are time-consuming suggests a lack of clear understanding, and thus appreciation of the nature, scope and functional potential of practical work by teachers, the origins of which are summed up by the suggestion that teachers "*lack proper training*" in practical work. Therefore, pre-service teacher training on practical fraction teaching needs to be revisited with an eye to addressing these and many other concerns which further research should help bring to the fore.

### In-service training

Teachers' concerns, their observed practices and their acknowledgement, that practical fraction division is relevant to OBE requirements for a learner-centred approach, call for a demand to look at how in-service training can assist to address teachers' needs. Instruction by means of rote application of the algorithm by teachers is a serious impediment to understanding. For practising teachers, in-service training seems to be the most immediately accessible remedy to their deficiencies. Flores (2002) advised that teachers who understand a topic should be able to make connections with other mathematical concepts and procedures. Recommended and approved in-service training programmes should be informed by teachers' perceptions of their needs directly solicited from them through relevant and appropriate research



strategies. Teachers' embracing attitude towards the relevance of practical fraction teaching to OBE is an encouraging point of departure. The ideas of the teacher from school B, on aspects of practical fraction teaching that OBE workshops should address, sum up the needs of teachers' in this regard. Such workshops should also ground teachers in more profound aspects of the concepts of fractions and fraction division (e.g. other fraction perspectives and fraction division situations).

### Teaching implications

Learners should be assisted with understanding various perspectives of the fraction concept and other meanings of division, e.g. sharing/partitive interpretations, using practical representations of fractions. That this is not an easy task is supported by the view that "... a review of literature indicates that the partitive meaning for division has almost been totally ignored ... The partitive meaning of division of fractions has been very resistant to clear concrete explanations" (Ott, Snook & Gibson, 1991:8). This calls for a commitment from teachers to seek and design effective strategies to help learners with the understanding of partitive and other perspectives of fraction division. For them to be successful, teachers' efforts in this regard need to be the overall outcome of teacher training initiatives both at pre-service and in-service levels.

## References

Cohen L, Manion L & Morrison K 2000. *Research methods in education*. London & New York: Routledge Falmer.

Cramer K & Bezuk N 1991. Multiplication of fractions: teaching for understanding. *Arithmetic Teacher*, 39:34-37.

Department of Education 1997. *Senior phase policy document (Grades 7-9)*. Pretoria: Department of Education.

Empson SB 2002. Organizing diversity in early fraction thinking. In: Litwiller B & Bright G (eds). *Making sense of fractions, ratios and proportions*. Virginia: National Council of Teachers of Mathematics.

Flores A 2002. Profound understanding of division of fractions. In: Litwiller B & Bright G (eds). *Making sense of fractions, ratios and proportions*. Virginia: National Council of Teachers of Mathematics.

Freudental H 1991. *Revisiting mathematics education*. Dordrecht: Kluwer Academic.

Fraser C, Murray H, Hayward B & Erwin P 2004. The development of the common fraction concept in grade three learners. *Pythagoras*, 59:26-33.

Gravemeijer KPE 2001. Developmental research: fostering a dialect relation between theory and practice. In: Anghileri J (ed.). *Principles and practice in arithmetic teaching*. London: Open University Press.

Hobden S 1999. The beliefs of pre-service teachers about mathematics teaching and learning. MEd dissertation. Durban: University of Natal.

Langa R 2003. Teachers' understanding of and use of assessment in the context of outcomes-based education: a case study of a Hammarsdale farm school. MEd dissertation. Durban: University of Natal.

Lubienski ST 1999. Problem-centred mathematics teaching. *Mathematics Teaching in the Middle School*, 5:250-255.

Moskal MB & Magone ME 2002. Making explicit what students know about fractions. In: Litwiller B & Bright G (eds). *Making sense of fractions, ratios and proportions*.

Virginia: National Council of Teachers of Mathematics.
Murray H, Olivier A & Human P 1996. Young students' informal knowledge of fractions. In: Morrison K (ed.). Paper presented at *Second national congress of the association of mathematics education in South Africa*. Natal: Interpak.
Ott JM, Snook DL & Gibson DL 1991. Understanding partitive division of fractions. *Arithmetic Teacher*, 39:7-10.
Patton M 2002. *Qualitative research and evaluation methods*. Thousand Oaks, London & New Delhi: Sage.
Sharp JM, Garofalo J & Adams B 2002. Children's development of meaningful fraction algorithms: a kid's cookies and a puppy's pills. In: Litwiller B & Bright G (eds). *Making sense of fractions, ratios and proportions*. Virginia: National Council of Teachers of Mathematics.
Siebert D 2002. Connecting informal thinking and fractions: the case of division of fractions. In: Litwiller B & Bright G (eds). *Making sense of fractions, ratios and proportions*. Virginia: National Council of Teachers of Mathematics.
Sinicrope R & Mick HW 1992. Multiplication of fractions through paper folding. *Arithmetic Teacher*, 40:116-121.
Sinicrope R, Mick HW & Kolb JR 2002. Interpretations of fraction division. In: Litwiller B & Bright G (eds). *Making sense of fractions, ratios and proportions*. Virginia: National Council of Teachers of Mathematics.
Whitworth D & Edwards M 1969. *Teaching mathematics to the ordinary pupil*. London: University of London Press Ltd.
Witherspoon ML 1993. Fractions: in search of meaning. *Arithmetic Teacher*, 40:482-485.

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