

TEACHERS' PERCEPTIONS AND USE OF ASSESSMENT INFORMATION: AN EXPLORATORY STUDY OF MATHEMATICS TEACHERS IN BRAZIL

Melise Camargo
melise.camargo@gmail.com

University of Cambridge

ABSTRACT

Classroom-based assessment has been a matter of concern and discussion in academia, especially in recent years. Many studies have been conducted, particularly about the implementation of formative assessment. Although it has been heralded as an important practice, there is still little research about this subject related to Mathematics Education, particularly in Brazil. Aiming to seek information about the types of approach that secondary-school Mathematics teachers in Brazil have been taking in their classrooms, survey research was conducted via an on-line questionnaire. The teachers were asked, among other aspects, about the frequency with which they apply and the importance they give to specific assessment methods or procedures. In this article, I present how Mathematics teachers are using the information gathered through assessment and how their conceptions are influencing their practices. Some recommendations and suggestions for further research are also presented.

Keywords: Assessment; Mathematics; Secondary-school; Brazil; Exploratory study.

RESUMO

As práticas avaliativas realizadas pelos professores secundários tem sido motivo de preocupação e discussão no meio acadêmico, especialmente nos últimos anos. Muitos estudos tem sido realizados, particularmente em relação à implementação da avaliação formativa em sala aula. Apesar dessa modalidade ser defendida como uma prática importante, ainda existem poucas pesquisas unindo-a com a Educação Matemática, e mais ainda quando voltado às escolas brasileiras. Buscando informações em relação aos tipos de avaliações que vem sendo realizadas pelos professores de Matemática das escolas públicas brasileiras, uma pesquisa foi realizada através de um questionário online. Os professores foram questionados, entre outros aspectos, sobre a frequência com que eles aplicam certos tipos de avaliações e qual a importância dada a cada um deles. Neste artigo, eu apresento como os professores de Matemática estão utilizando as informações coletadas através da avaliação e como suas concepções estão influenciando suas práticas. Também são apresentadas algumas recomendações e sugestões para futuras pesquisas.

Palavras-chave: Avaliação; Matemática; Ensinos Fundamental e Médio; Brasil; Estudo exploratório.

1. Introduction

The issue of assessment has been a subject of intense research. Discussions concerning the importance and purposes of assessment have played a central role among researchers, particularly about its formative and summative functions, with evidence that the former improves learning (Black & Wiliam, 1998a).

Even so, as argued by some researchers (James & Lewis, 2012; Shepard, 2002), it seems that the re-shaping of assessment is not occurring at the same pace as the re-shaping of instruction. Classroom assessment still follows the old paradigm, supported by summative concepts, while instruction is changing towards a constructivist paradigm (more formative oriented).

In the field of Mathematics Education, the scenario is no different. Despite the clear evidence that the formative use of assessment improves learning, “few formative assessment programs offer guidelines about implementation and use [...] and which kind of formative assessment will be most effective for students, as well as how to train teachers to use the strategy they adopt” (Frohbieter, Greenwald, Stecher, & Schwartz, 2011, p. 2).

Recognising the relevance of teachers’ conduct to the development of assessment practices, the present study aimed to analyse which types of approach have been adopted by secondary-school Mathematics teachers in Brazil to assess their students. This study also aimed to analyse if there is any evidence that they are implementing assessment with a formative purpose.

2. Focusing on teachers’ assessment practices

The expression assessment practices does not simply refer to techniques, procedures or instruments. It has a broader meaning, covering events that occur in the assessment of daily school work. Both formal procedures, i.e. those that are planned and which inform students that they are being evaluated (e.g. tests and homework); and informal procedures, that occur through the interaction of teachers with students and the students themselves (e.g. observations of students responses in class), can be included in these criteria.

Black and Wiliam (1998a), in their seminal work, discuss the results of studies conducted by Crooks (1988) and Black (1993), which revealed many weaknesses in assessment practices:

- the practices generally encouraged superficial and mechanical learning, focusing on memorizing isolated details, usually items that students would quickly forget;
- teachers, in general, did not review the assessment tasks and procedures. Moreover, they were not critically discussed with the students, which indicated little reflection on what was being assessed;
- the attribution of marks was the primary purpose rather than the promotion of learning;
- there was a tendency to conduct norm-referenced rather than criterion-referenced assessment, which emphasized the competition among students, leaving aside the

development of each pupil individually. The authors point out that this practice meant that the feedback was used primarily to inform weaker students about the skills they lacked. As a consequence, they were discouraged to believe in their own ability to learn.

In this section, I present some formative assessment practices embedded in the educational environment to which they belong. There are no specific practices for this kind of assessment. The way to develop them and take advantage of the information they provide is what links them to the formative role. The same test, for example, can be used for both formative and summative assessment. It is the purposes and uses made of the results that indicate what function it serves. Self-assessment by students is another example. However, it does not necessarily mean that formative assessment is being used. Thus, it is important to note that there are certain factors that must be taken into account since they can influence and explain some assessment practices.

Askew, Brown, Rhodes, Wiliam, and Johnson (1997), in a study of elementary school teachers, found a strong relationship existing between learners' progress in Mathematics and their teachers' pedagogical content knowledge, which suggests that the way in which teachers assess their pupils depends on how they interpret and explore the subject-matter.

That is to say, if a teacher believes that Mathematics must be taught as a set of algorithms or rules, his/her assessment will probably focus on gathering information about whether the student is able to memorize and reproduce them or not. On the other hand, if the teacher believes that Mathematics should be taught based on problem solving, where different students' solutions and attempts are taken into account, probably his/her assessment practices will follow this pattern. Thus, the way in which the teachers see the subject-matter will influence the way in which they assess their students.

The teachers' perceptions of assessment also influence their classroom assessment practices. Susuwele-Banda (2005), using a questionnaire, interviews and observations concluded that teachers perceive classroom assessment as tests that they give to their students at specific time intervals. Moreover, as they perceive classroom assessment as tests, they showed a limited ability to use different methods and tools to assess their students.

In contrast, Pacheco (2007) investigated teachers' assessment conceptions in Brazil and evidenced that, although the participants are still implementing assessment with summative purposes, they recognise the importance of formative assessment and the use of diverse instruments and procedures to assess their students.

The same characteristics were found in the study conducted by Albuquerque (2012), who concluded that, although teachers recognised the necessity of using different methods and instruments to assess their students, the two methods that they used widely are homework assignments and tests. Indeed, some of them still use tests as the only method based on the justification that it is the most practical and objective method, and also because of the time constraints and number of students per class. Homework was mentioned as being used only to provide marks related to the fulfilment of the task or not.

In many cases, as reported by Johnston and McClune (2000), teachers adjust their teaching style in ways they perceive as necessary because of the tests. They spent most of the time on direct instruction and less on providing opportunities for their students to learn. Moreover, Harlen (2004) shows that the teachers' assessment practices are inevitably influenced by the external assessment, and that teachers often use these assessments as models for their own, even if they do not use them directly.

Similarly, Frohbieter et al. (2011) advocate that differences in teachers' understanding of assessment and Mathematics would clearly generate differences in terms of the information they gather from assessments. Likewise, a teacher with a strong understanding of the various purposes of assessment and assessment techniques will probably draw more information from an assessment than one with less expertise in this topic.

An important result of their study was related to the variations among three different programmes they analysed and the professional development course that the teachers had the opportunity to take. As the training was not mandatory, it was possible to compare the practices between the teachers who took part in the training and those who did not. Moreover, it was possible to compare the differences and commonalities among the kinds of course that had been offered.

The authors point out that there was considerable variation among the teachers with regard to the information that they obtained from the assessments and how they used it. They felt that more autonomous action and varied practices occurred within the practice of teachers who took part in the courses, which also seemed to be accompanied by more integrated use during the school year; i.e., they concluded that the training courses were somehow influencing their practices.

The findings discussed above show that there are many factors that can influence classroom assessment. All of them are related to the way in which the teachers orientate their practices. Because of this, it is important to discuss the teachers' role in the use of assessment to regulate learning.

2.1. Teachers and the use of assessment in the regulation of learning

Considering the regulation of learning, Perrenoud (1998) divides it into two phases. The first is related to the ways in which teachers plan and set up their actions. The second is related to teachers' actions during the implementation of these planned actions.

This idea can be linked with the three key characteristics of formative assessment advocated by Frohbieter et al. (2011, p. 4):

- Purpose: the way the information is intended to be used;
- Cycle of use: how assessments are integrated into the instructional calendar, in particular, the frequency of their administration and the rapidity with which results can be accessed;

- Planned integration with instruction: the assessment activities designed or selected in order to provide information for instructional improvement and embedded to some degree in instructional activities.

Based on these characteristics, the authors analysed three Mathematics formative assessment programmes, which showed many different approaches to formative assessment.

Several teachers reported using some form of warm-up exercises and/or pre-assessment at the beginning of an instructional unit in order to determine whether or not their students had specific skills or had mastered the topics that would be covered. Some teachers also reported using these assessments to understand some more of the more common mistakes made by their pupils as well as exploring where a solution process had broken down and why, or describing a partially-correct conception that produced the right answers only in certain cases. Many of them pointed out that they preferred using tests with open-ended questions (constructed-answers) because this allows them to see what their students are thinking a lot more clearly. According to the authors (Frohbieter et al., 2011, p. 15), “teachers used these assessments intentionally to obtain information on which to base instructional decisions, which indicates formative purpose”. Additionally to tests, some teachers reported also using informal observations, quizzes and homework assignments.

However, just an intention is not enough. It must be accompanied by action. In relation to this, Frohbieter et al. (2011) presented many of the actions that teachers took when using the information from assessments and divided these according to the degree of sensitivity and customization. The action ‘record the marks and move to the next topic’ was the least responsive action taken in relation to assessment.

Among those which were considered as moderately responsive actions were:

- Provide a review of all or part of the content using a simplified example of the problem or the students’ solution attempts;
- Encourage the students to develop different study plans;
- Use the information from the assessment to guide the assignment of additional work;
- Use self-assessment or peer-assessment (without specific criteria);
- Evaluate whether or not the method of assessment worked.

Finally, the highly responsive actions were:

- Tailor the teaching in an effort to cover the perceived weaknesses or build on perceived strengths;
- Develop different teaching strategies;
- Form like-ability groups with the intention of differentiating instruction for individuals or small groups of students;
- Use self-assessment or peer-assessment, asking the students to analyse and revise any errors and develop explanations or justifications of their own mathematical thinking;
- Provide written comments on individual students’ work;
- Go over assessment tasks with the class in a later lesson;

- Give the students the opportunity to discuss the different ways they used to solve particular problems;
- Provide students with new opportunities to demonstrate their progress and/or difficulties.

While Frohbieter et al. (2011) analysed the current practices of the teachers, Black, Harrison, Lee, Marshall, and Wiliam (2003) focused their actions in the King's-Medway-Oxfordshire Formative Assessment Project (KMOFAP) on strategies that emerged from the teachers' needs. They implemented changes in relation to classroom questioning, feedback through marking, peer- and self-assessment, and the formative use of summative tests. Referring to the latter, the teachers started their changing by using the following strategies:

- Encourage their students to reflect using traffic lights in order to improve their review schemes (green when they felt that they had understood the task or concept, and amber or red to label activities with which they still had problems understanding and/or solving);
- Suggest that the students, in groups or pairs, should generate and then answer their own questions. The teachers believed that “when students are encouraged to set questions and mark answers, this can help them both to understand the assessment process and to focus further efforts for improvement” (Black et al., 2003, p. 54);
- Analyse the results of the tests more deeply to see which questions the majority of their pupils have had problems in answering and then redirect their teaching. For those questions which only a few students had a problem in answering, they were encouraged to find someone in the class who could explain how they had answered them correctly.

Although the authors (Black et al., 2003, p. 53) state that teachers were trying “to [use] formative strategies to aid preparation for summative tests, and using them as a means of identifying learning targets from the detailed evidence that summative test questions could produce”, it seems possible, based on the results reported, that the first approach was used more frequently, which can be seen as the continuing influence of the pressure to succeed in tests. Similarly, Harlen (2006) points out that there are several limitations to this approach, arguing that it would be necessary to make fundamental changes if it is going to be designed to serve both approaches.

Referring to classroom questioning, the teachers were incentivised to give more time to students to think up in their responses. The main aim of this change was to try to have a discussion in which all the responses (whether right or wrong) were taken seriously and able to provide information about students' pre-knowledge together with any gaps or misconceptions, so that teachers could plan their next actions for addressing the students' needs. These changes made the teachers realise that it would also be necessary to spend more time designing the questions, so they could indeed evoke the students' understanding.

Based on the pieces of research reviewed and the fact that almost no research related to Brazil was found, four specific research questions were addressed:

1. Which types of approach have been adopted by Mathematics teachers in Brazil to assess their students?
2. How are they using the information gathered from assessments?
3. Is there any evidence that professional development courses have influenced their approach to assessment?
4. Is there any connection between their conceptions and their approach to assessment?

The results from questions 1 and 3 were already presented elsewhere. In this article therefore, I present and discuss the results of questions 2 and 4.

3. Methodology

As the main goal of this research was to explore what types of approach have been adopted by Mathematics teachers in Brazil for assessing their students and some issues that could possibly influence their approach to assessment, an exploratory e-questionnaire survey was implemented (Cohen et al., 2011). This allowed a large volume of standardised data to be collected in a short period of time and at a low cost, from a broad sample (Kelley, Clark, Brown, & Sitzia, 2003).

3.1. Sample

As mentioned above, the questionnaire was delivered to Mathematics teachers in Brazil. Due to the large number of teachers in the population, it was necessary to select a sample to participate in the study.

Hence, I decided that the questionnaire would be delivered only to those who were tutors in the Gestar II Programme, which was a teacher-training course offered to teachers in secondary public schools, across the whole country, from 2008 to 2011.

The course was organised in a cascade mode, comprised of trainers, tutors and course participants. The trainers, a team from the University of Brasília, were responsible for training the tutors. These tutors then had an intermediate role, which was to be responsible for training the other teachers, who became course participants, within their own states. The tutors were nominated by the local government and the number varied according to the number of teachers in each state.

The choice of this sample was made essentially in order to facilitate the data collection, since I was one of the trainers, and still had access to the tutors. Moreover, having access to all the regions in Brazil would produce more accurate results about the assessments being used throughout the country. Thus, in this particular study, the sample can be characterised as *an opportunity sample that, conveniently for purpose, is already geographically clustered*.

3.2. The questionnaire

As said before, a structured on-line questionnaire was adopted. This questionnaire was designed using the web-application Qualtrics® and was divided into five sections.

The first section (Q1 to Q7)¹ was designed with the intention of defining the context and classifying the data. It required the teachers to provide profile information, such as their age, qualifications, teaching experience, etc.

The second part (Q8 to Q12) comprised questions about assessment in general. The teachers were invited to choose which kinds of assessment they are used to using with their students and the frequency with which they apply them. The teachers were also invited to state the degree of importance they assign to each of the instruments in the previous question.

The response options provided for these two questions were taken from other studies (Albuquerque, 2012; Black et al., 2003; Black & Wiliam, 1998b; Brookhart et al., 2004; Hodgen & Wiliam, 2006) as well as from my experience as a Mathematics teacher. However, as previously mentioned, there is no unique or ideal way of assessing students. Similarly, it was impossible to predict and list all of the types of assessment available. In order to overcome this drawback, I also included the option *other* in case the teacher is using another type of assessment that was not listed in the question.

The third section (Q13 to Q16) was related to the use of tests. This section was created following my reading of the arguments and the results of other studies, which showed that many teachers still see assessment as the implementation of tests at the end of a period (Albuquerque, 2012; Johnston & McClune, 2000; Susuwele-Banda, 2005). This was therefore a response to the first research question. I wished to understand how teachers design their tests, and which actions they are used to undertaking before a test is applied.

The fourth section (Q17 to Q20) comprised questions about homework assignments since this was the second most frequently mentioned type of assessment in the studies in Brazil (Albuquerque, 2012; Villas Boas, 2011).

In section five (Q21 to Q23), the teachers were asked about the actions taken after the implementation of an assessment. The items were designed based on a careful analysis of the literature (Frohbieter et al., 2011; Hodgen & Wiliam, 2006; Villas Boas, 2011) where it was possible to collect data about some practices that have been adopted by Mathematics teachers worldwide. As with the other sections, I included an open-ended question where the teachers could recall other actions which they usually take but had not previously mentioned. This section was created in order to answer the second and fourth research question.

In the last section (Q24 to Q28), in order better to understand the approaches to assessment adopted by the teachers, some statements relating to assessment and to Mathematics in general were included and the teachers were invited to state whether they agree with them or not. The main goal of this section was to link their pedagogical orientation and view of Mathematics with the types of assessment that they employ in their classes. The statements were taken from the literature (Frohbieter et al., 2011; Hodgen & Wiliam, 2006; Pacheco, 2007) in order to use data that had already been collected via previous research and develop a more realistic view of the practices being developed in Mathematics classes in Brazil.

¹ The notation Q_{x,y} will be used to represent the question (x) and the item (y) within the questionnaire.

Another question, in which some approaches to assessment were presented and the teachers could select which of them they might be interested in learning, was also included. The types of assessment included were collected from a review of studies conducted solely in Brazil (Lopes & Muniz, 2010; Pacheco, 2007; Valente, 2008; Villas Boas, 2011). I aimed to include those types which were often discussed as well as those which were rarely mentioned. The information collected from this particular question provided some indications for further research.

The response options provided for all questions were taken from other studies (Albuquerque, 2012; Black et al., 2003; Black & Wiliam, 1998b; Brookhart et al., 2004; Hodgen & Wiliam, 2006) as well as from my experience as Mathematics teachers. The Portuguese version was developed using terms that are widely used in the Brazilian teachers' daily practices, and reviewed by a specialist in assessment in Mathematics Education (from Brazil). When judged necessary, some specific items had further explanation (e.g. long tests (taking more than one hour to complete)). In its final version, the questionnaire was comprised of 28 questions.

4. Findings

Following a quantitative analysis, the first step was to use descriptive statistics to assess the overall behaviour of the data. The relevant findings are presented in the form of tables and figures. After that, I divided the questionnaire according to the research questions, and cross-tabulation tables were generated to analyse the degree of association and homogeneity among all of the questions that were related.

The analysis of the significance was made through a Kendall's tau-b test, which measures the relationship between two ordinal or ranked variables. The sign of the coefficient indicates the direction of the relationship, and its absolute value indicates the strength, with larger absolute values indicating stronger relationships. The possible values range from -1 to +1, but the extreme values can be obtained only from square tables (Sirkin, 2006). When a Kendall's tau-b was used, the results are shown in the text as:

$$(\tau_B = q, p < \alpha),$$

where q is the observed value of the τ_B statistic and p is the p-value, which is compared to the significance level α . In the social sciences, the minimum level of probability at which a result can be regarded as significant is $p < 0.05$.

Due to the size of the tables, only the relevant information will be presented in the text.

4.1. Respondents' profiles

The questionnaire was answered by 332 Mathematics teachers, which can be considered an acceptable sample size since this study is characterised as an exploratory one, where the findings were not intended to be generalised to the entire target population.

The majority of the respondents are experienced teachers with more than 16 years of teaching, having at least a post-graduate degree. The Northeast was the region with more

respondents and those from the North comprised the minority. The remainder was almost equally distributed among the Southeast, South and Midwest. Figure 1 shows the distribution across regions.

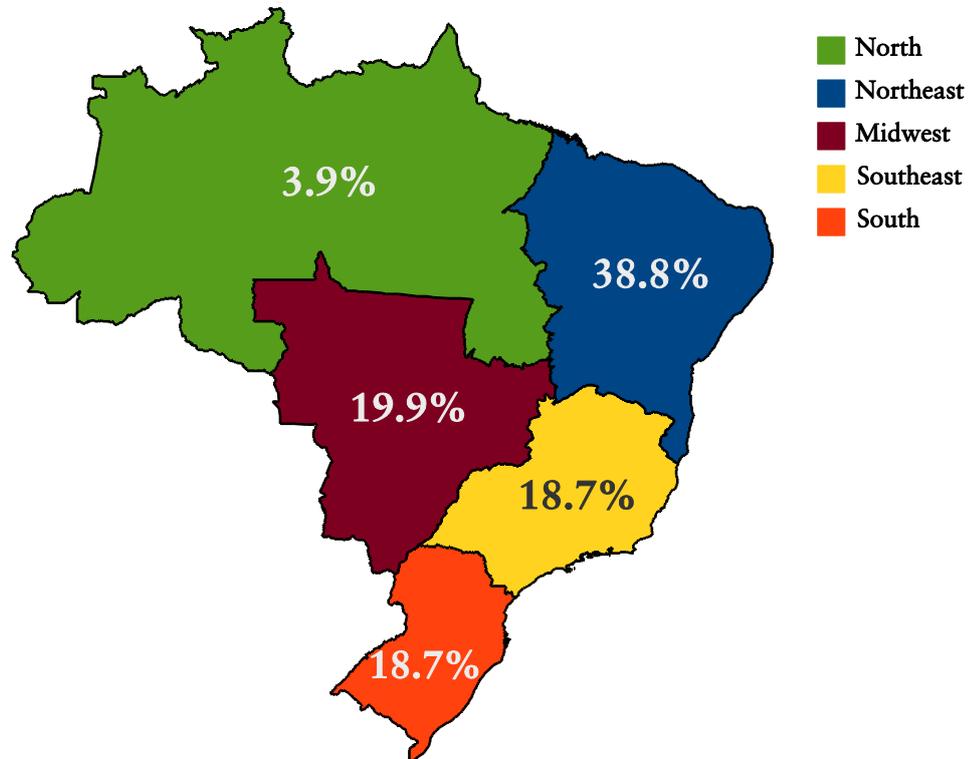


Figure 1: Distribution of respondents across regions.

4.2. Teachers' use of assessment information

In this section, the results of research question two will be discussed. It starts by presenting the frequency of certain general actions (Q21) that can be taken based on the information gathered from the assessment, followed by an analysis of some of the more specific and detailed actions (Q22). After that, both questions are compared in order to show some of the differences and relationships among their items.

In this way, table 1 provides information about the frequency of some of the actions which the respondents take based on the information gathered from assessment.

Table 1: Frequency of teachers' uses of information from assessments.

Question 21: When you gather assessment information from students, how regularly do you use this information to take the following?	Rarely or never	Occasionally	Every time or almost every time
21.1: Provide students' grades or marks?	0.3% ² (1)	16.6% (55)	83.1% (276)
21.2: Provide feedback to students?	5.1% (17)	22.9% (76)	72.0% (239)

² The first value represents the percentage of the row. The second (in parentheses) is the count value.

21.3: Diagnose students' learning?	0.3% (1)	9.9% (33)	89.8% (298)
21.4: Plan future lessons?	2.4% (8)	15.7% (52)	81.9% (272)
21.5: Report to parents?	10.2% (34)	38.0% (126)	51.8% (172)
21.6: Assign students to different programmes or tracks?	57.2% (190)	30.4% (101)	12.3% (41)

The results show that the great majority of teachers use the information obtained from assessments to *diagnose students' learning* (Q21.3), with 89.8% stating that they do this *every time or almost every time*. On the other hand, item Q21.6 is the less frequently used approach, with 57.2% of the respondents claiming that they *rarely or never* use the information from assessments to *assign students to different programmes or tracks*.

Although it is possible to highlight the items that are most and least frequently used, it is important to observe that a great number of teachers also state that they use the information obtained from assessments to *provide students' grades or marks* (Q21.1; 83.1%), *plan future lessons* (Q21.4; 81.9%) and *provide feedback to students* (Q21.2; 72.0%), which may be indicative that they are using the information from assessments for different purposes. *Report to parents* (Q21.5) was the item with the most variation, showing a division between doing this *occasionally* and *every time or almost every time*.

In a more specific way, table 2 provides a list of the items that were least and most frequently indicated as being used after assessments (Q22)³.

Table 2: Actions taken after an assessment.

Question 22: How often do you take the following actions after an assessment?	Rarely or never	Occasionally	Every time or almost every time
22.14: Go over the assessment tasks with the class in a later lesson	1.8% (6)	19.0% (63)	79.2% (263)
22.5: Use the information from assessments to tailor the teaching in an effort to cover the perceived weaknesses	3.6% (12)	21.4% (71)	75.0% (249)
22.10: Use self-assessment or peer-assessment (without specific criteria)	51.8% (172)	34.0% (113)	14.2% (47)
22.9: Use the information to form like-ability groups with the intention of differentiating the instruction for individuals or small groups of students	38.9% (129)	38.0% (126)	23.2% (77)

The results indicate that *go over assessment tasks with the class in a later lesson* (Q22.14) and *use the information from assessments to tailor the teaching in an effort to cover the perceived weaknesses* (Q22.5) were the actions that the majority stated doing *every time or*

³ The remainder of the table can be found in appendix 1.

almost every time. This result contradicts one of the findings of Black and Wiliam (1998a), which indicated that teachers, in general, did not review the assessment tasks and procedures with their students.

Moreover, there is a statistically significant relationship ($\tau_B = 0.373, p < 0.0001$) between Q22.5 and Q22.8, which shows that there is a good number of teachers (58.1%) who use the information from assessments to tailor their teaching in an effort to cover the perceived weaknesses and also to build on their perceived strengths, which is noteworthy since they are not only paying attention to the skills that the students lack but also encouraging them to believe in their own abilities (Black & Wiliam, 1998a).

In contrast, the items indicated as being less frequently used were *self-assessment or peer-assessment (without specific criteria)* (Q22.10) and *form like-ability groups with the intention of differentiating the instruction for individuals or small groups of students* (Q22.9) with 51.8% and 38.9% of the respondents stating that they rarely or never use the information from assessment to take these actions.

In fact, there is a statistically significant relationship between Q21.6 and Q22.9 ($\tau_B = 0.282, p < 0.0001$), showing that, of the teachers who stated that they *rarely or never* use the information from assessments to *assign students to different programmes or tracks* (Q21.6), the majority also stated that they *rarely or never* use it to *form like-ability groups with the intention of differentiating the instruction for individuals or small groups of students* (Q22.9), confirming that this is not a common practice among them.

Moreover, it can be noted that 63.4% of the teachers who stated that they *rarely or never use self-assessment or peer-assessment (without specific criteria)* (Q22.10), also stated that they *rarely or never* use it *asking students to analyse and revise errors and develop explanations or justifications of their own mathematical thinking* (Q22.1; $\tau_B = 0.551, p < 0.0001$). Therefore, although the literature (Black & Harrison, 2001; Black et al., 2003; Brookhart et al., 2004; Frohbieter et al., 2011; Villas Boas, 2011) indicates the importance of these two approaches to a formative use of assessment, they are still not common practice among the respondents.

Even though the items Q22.12 and Q22.13 were not among those selected as being more frequently used after an assessment, an interesting characteristic was observed. Although 72.0% of the respondents stated using the information from the assessments *to provide feedback to students every time or almost every time*, in Q22, the majority of teachers stated giving written feedback *occasionally*. Of these, 43.7% provide it *without marking* (Q22.12), and 44.9% provide comments and *also a mark* (Q22.13). On the other hand, of the total, the number of teachers who stated that they give a mark along with comments *every time or almost every time* (31.6%) is higher than that of those who provide written feedback only (28.6%).

Another important observation is that, of the 272 teachers who stated that they use the information from assessments *to plan future lessons* (Q21.4) *every time or almost every time*, 79.0% also use it to *develop different teaching strategies*

(Q22.6; $\tau_B = 0.328, p < 0.0001$) and 69.1% are used to use the information to *guide the assignment of additional work* (Q22.4; $\tau_B = 0.373, p < 0.0001$).

Finally, it is possible to observe the existence of a statistically significant relationship between Q22.2 and Q22.3 ($\tau_B = 0.449, p < 0.0001$), which indicates that the majority of teachers who tend to *provide a review of all or part of the content using simplified example problems or exercises occasionally* also provide this review *using the students' solutions attempts*. The same applies to those who state that they do so *every time or almost every time*.

However, there is a division between the frequency with which the teachers *provide a review of all or part of the content using the students' solution attempts* (Q22.3). While 46.4% of the respondents stated that they do so *occasionally*, 45.2% claimed that they do so *every time or almost every time*. Moreover, the results show that there is a statistically significant relationship between Q22.3 and Q22.15 ($\tau_B = 0.316, p < 0.0001$), showing that the teachers who provide the review using the students' attempts *every time or almost every time* also *give them the opportunity to discuss the different ways they used to solve particular problems*, which may be indicative that teachers are allowing the students to play a central part in their own learning process (Harlen & James, 1997).

4.3. Connections between teachers' conceptions and their approaches to assessment

In this section, the results of research question four will be discussed. The respondents were invited to state how strongly they either agreed or disagreed with some statements referring to assessment conceptions. Thus, this section presents the statements with which the majority of respondents agree or strongly agree, as well as disagree or strongly disagree, along with some comparisons with the answers they provided to other questions (table 3).

Table 3: Assessment conceptions⁴.

Question 24: To what extent do you agree or disagree with each of the following statements?	Strongly disagree	Disagree	Agree	Strongly agree
Q24.6: The teacher should make use of different instruments and types of activity (seminars, worksheets, tests) to assess his/her students.	0.0% (0)	1.5% (5)	28.0% (93)	70.5% (234)
Q24.2: The test is just a partial instrument, since it measures the recovery of some of the content covered, but does not reveal the actual conditions of the pupils.	0.3% (31)	2.7% (9)	47.0% (156)	50.0% (166)
Q24.8: Tests are the most appropriate way to measure whether the contents were satisfactorily learnt by the students or not.	9.3% (31)	59.3% (197)	24.7% (82)	6.6% (22)
Q24.5: When the assessment results are unsatisfactorily, it is necessary to review the contents in order to help the students to overcome their difficulties.	0.0% (0)	3.6% (12)	37.7% (125)	58.7% (195)

⁴ The remainder of the table can be found in appendix 2.

Q24.3: The function of assessment is to analyse the necessary steps for meeting the teaching and learning goals	0.3% (1)	3.9% (13)	47.3% (157)	48.5% (161)
Q24.10: The objectives, content and learning activities should be redesigned according to the results obtained from the students' assessments.	0.6% (2)	5.4% (18)	46.7% (155)	47.3% (157)
Q24.9: Assessment aims to identify the performance and causes of students' difficulties.	0.6% (2)	15.1% (50)	67.5% (224)	16.9% (56)

First of all, there is a high agreement among the respondents (98.5%) that *the teacher should make use of different instruments and types of activity to assess his/her students* (Q24.6), which in fact was supported by the questionnaire, since all of the respondents reported using one or more method/procedure to assess their students.

This result also explain why 97.0% of the respondents agreed that *the test is just a partial instrument, since it measures the recovery of some of content covered, but does not reveal the actual conditions of pupils* (Q24.2) and 68.6% disagreed that *tests are the most appropriate way to measure whether the contents were satisfactorily learnt by the students or not* (Q24.8).

The majority of the teachers (96.4%) also *agree or strongly agree* that *when the assessment results are unsatisfactorily, it is necessary to review the contents in order to help the students overcome their difficulties* (Q24.5). However, only 45.9% of them stated that they provide this review *using the students' solution attempts* (Q22.3) *every time or almost every time* ($\tau_B = 0.182, p < 0.001$). This percentage is even smaller (39.7%) when referring to whether the teachers *provide a review of all or part of the content using simplified example problems or exercises* (Q22.2; $\tau_B = 0.154, p < 0.005$).

Another important statement that had a high degree of agreement among the respondents (95.8%) was that *the function of assessment is to analyse the necessary steps to meet the teaching and learning goals* (Q24.3). This agreement was proven by some actions reported by them in the questionnaire. For example, 82.7% of the teachers who *agreed or strongly agreed* with Q24.3 also stated that they use the information from assessments *to plan future lessons* (Q21.4), *every time or also every time* ($\tau_B = 0.221, p < 0.0001$).

This relationship was also observed in some items of Q22, where 75.5% of them stated using the information from assessments *to tailor the teaching in an effort to cover the perceived weaknesses* (Q22.5; $\tau_B = 0.124, p < 0.05$); 69.2% use it to *tailor the teaching in an effort to build on strengths* (Q22.8; $\tau_B = 0.174, p < 0.001$); 64.5% of them stated that they use the information *to guide the assignment of additional work* (Q22.4; $\tau_B = 0.168, p < 0.001$); and 73.9% *to develop different teaching strategies* (Q22.6; $\tau_B = 0.182, p < 0.001$).

A statistically significant relationship was also observed among the last two actions mentioned above and item Q24.10, where 94.0% of the respondents *agreed or strongly agreed* that *the objectives, content and learning activities should be redesigned according to*

the results obtained from students' assessments. From them, 74.0% also reported Q22.6 ($\tau_B = 0.257, p < 0.0001$) and 65.1% stated Q22.4 ($\tau_B = 0.237, p < 0.0001$).

Finally, *assessment aims to identify the performance and causes of students' difficulties* (Q24.9) was another item that attracted strong agreement among the respondents (84.4%), as confirmed by the fact that 90.4% of them also reported using the information from assessments to *diagnose students' learning every time or almost every time* in Q21.3 ($\tau_B = 0.112, p < 0.05$).

In a way, it was possible to observe that there are some connections among the teachers' conceptions and their approaches to assessment.

5. Discussion and Conclusions

Formative assessment has been declared to be an important way of improving teaching-learning process. However, adopting formative assessment does not mean abandoning all that is being done and adopting a completely different process. As an on-going process, to start it requires analysing the actions in development, and the benefits and weaknesses presented, so that it is possible to organise a work schedule. As an exploratory study, this was the main goal: to collect information about the types of approach adopted by Mathematics teachers in Brazil, particularly in secondary-schools, in order to be able to propose some changes to their practice towards a formative assessment. In this section, some results from the other three research questions will be presented in order better to contextualise the discussion.

First of all, it was possible to observe that, although the teachers use different kinds of assessment and with different frequencies, tests and homework assignments are the two methods that are most commonly used by secondary-school teachers, as corroborated by the importance that the teachers said they give to them, which confirms the results of other studies (Albuquerque, 2012; Pacheco, 2007; Susuwele-Banda, 2005). As the questionnaire had two specific sections addressing these methods, it was possible to analyse in more detail how they are using them.

Referring to the tests, before setting them, the teachers reported frequently giving a review lesson, in which they include the contents that were covered in previous lessons, as well as practice in basic skills and in tasks similar to those contained on the test. This action could be considered summative, if the intention is simply to prepare the students to do well in the test, i.e., if the teachers are just aiming to get good results in the test. On the other hand, if the review also has the intention of promoting learning and helping the students to understand their strengths and weaknesses in order to use the content covered to see what is the next step in their learning process (Harlen & James, 1997), it can be considered a formative use.

The same can be said in relation to the type of questions that the teachers include in their tests and the kinds of skill they require from their students to answer them. The respondents reported that most of their tests were comprised of open-ended questions, involving the application of mathematical procedures.

This can be considered a good indicative, although it is impossible to affirm if they include these questions in order to try to understand the students' thoughts and make use of this to guide their teaching to suit the students' needs, or if they are just encouraging superficial, mechanical learning, focused on memorizing isolated details, such as the weak practices which Black and Wiliam (1998a) reported.

Similarly, some comments can be made about homework assignments. The majority of the teachers reported that they assign exercises and problems from the textbook to their students. After that, they record whether or not the homework was completed and give feedback to the whole class. Based on these statements, it seems that homework assignments are being used just for accountability, where the teachers are not considering the student's individual performance, just if they have completed the assignment or not, without taking into account what has been answered, to be used as indicative of what the students have learnt and what they still need to improve.

However, the data did not provide information to make this assumption with any certainty. A deeper analysis of how this feedback is being given would be needed in order to conclude whether or not it is being used for the improvement of learning or if it is being used just to correct and show what is wrong or right in the assignment. It would be necessary to verify if the teachers give the students the opportunity to think about their learning status and how it is possible to focus on the aspects that they still need to improve, as well as if the teachers are giving their students the opportunity "to act upon the feedback and also discuss the feedback with others" (Hodgen & Wiliam, 2006, p. 19).

By the way, providing written feedback was not included among the actions most frequently taken by the respondents when asked about how they use the information obtained from assessments. The majority stated that they do it occasionally and also add a mark, which shows that this practice still needs to be improved since Butler (1988) has proved that feedback based on comments only brings more learning gains and Black et al. (2003) confirmed that this is a practicable approach.

Still referring to the teachers' use of the information gathered from assessments, the great majority of the participants reported using it to diagnose their students' learning. Therefore, in order to become a formative use of assessment, it is necessary to analyse what they are doing after this diagnosis and if they are using it to "adjust their ongoing instructional procedures" (Popham, 2008, p. 6).

About this argument, the data did provide some indicatives. Firstly, the teachers reported that they go over the assessment tasks with their students. Secondly, they affirm using the information from assessments to plan future lessons and also to tailor their teaching in an effort to cover any perceived weaknesses. In all of these actions, it can be seen that, in a way, the teachers are using the information obtained from the assessments with the intention of promoting learning (Harlen & James, 1997). However, what could also be observed is that the teachers still do not include their students in this process. In other words, all of the actions reported are left up to the teachers to take. This was also proven by the low rates in relation to the use of self- and peer-assessment.

Although the literature (Black & Harrison, 2001; Black & Wiliam, 1998a; Brookhart et al., 2004; Sebba et al., 2008) argues that both practices are essential for a formative use of assessment, they are still not common practice among the respondents. In all of the questions in which self- and peer-assessment were included, they were reported as being rarely or never used. This did not happen among the teachers who reported having undertaken in-service teacher training on assessment and this is another subject that deserves some consideration.

First, the teachers were asked only if they have undertaken any in-service courses or not. The results show that the great majority have participated in these trainings. However, the data did not provide information about if the course was specifically about assessment, if it also dealt with the different approaches to teaching and learning, if it was about a specific type of assessment, or even if it was designed to link the theory and practice.

Secondly, the analysis showed that the only difference that was observed among the teachers who have undertaken a course or not was in relation to the frequency of implementing self-assessment. Even for these teachers, tests and homework assignments are still the most frequently used methods, and the most important. In a way, it was possible to conclude that there was almost no evidence that teacher training courses influenced their approaches to assessment.

Finally, it was possible to observe that most of the conceptions that the teachers have about assessment were corroborated by their practice, or vice versa (Pacheco, 2007). They agree that they must make use of different methods to assess their students, and indeed do so. Likewise, they agree that the function of assessment is to analyse the necessary steps to meet the teaching and learning goals. This statement was also corroborated by other answers. However, it is also necessary to make a deeper analysis of these practices in order to conclude whether they are being implemented with formative purposes or not.

6. Recommendations and implications for further research

The results of this research showed that Mathematics teachers most frequently use tests and homework assignments as types of assessment. Hence, it is plausible that any change must start by taking this into consideration and trying to use them in a formative way. Although Black et al. (2003) already have shown some practices that could be implemented using summative tests with formative purposes, further research on this subject and homework assignments can still be done.

Similarly, as self- and peer-assessment are heralded as important tools for formative assessment, these changes must include both practices, aiming, for example, to develop the perceptions and beliefs of students about their own learning, and also to divide the responsibility between learners and teachers. Furthermore, this could also include the use of ICT since this was the approach that the majority of the respondents are interested in learning more about, as shown in figure 2.

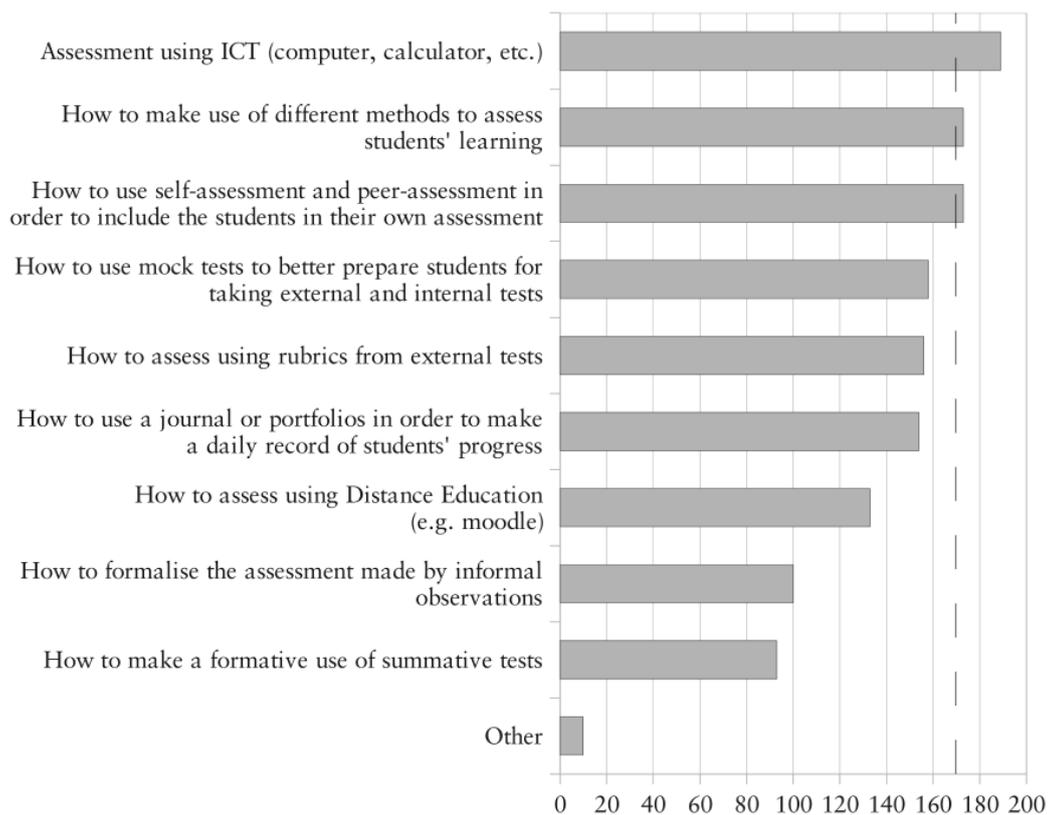


Figure 2: Types of approach teachers want to learn more about.

Moreover, as discussed in the previous section, the data provided information about which practices are being implemented, but did not tell us why and how. So, further research should seek to develop a deeper understanding of these practices, in order to better explain and underpin the proposed changes. It could start by analysing how the feedback is being given to the students, and if both students and teachers are using it to guide and improve the teaching-learning process. Within this practice, it could be investigated, for example, how teachers interpret the students' responses in order to write the feedback and if they instruct the students on how to improve; and also how students interpret the feedback given by teachers and which strategies the students are developing to overcome the weaknesses presented by the teachers. Moreover, the use of feedback could also be linked with the use of ICT, since it could help to provide immediate feedback, bringing more gains to learning (Corbett & Anderson, 2001).

The results also indicated that the in-service teacher training courses have little influence in their approaches to assessment. Therefore, a detailed analysis of these courses would be necessary and probably help to suggest ways in which they should be designed and implemented.

Finally, studies that investigate how the beliefs of teachers about learning and about their roles as assessors interfere in the way they assess their students are also needed, since this will influence the way they see the students' work, and as a consequence, the quality of assessment they are providing.

7. References

- Albuquerque, L.C. (2012) *Avaliação da aprendizagem: concepções e práticas do professor de matemática dos anos finais do ensino fundamental* [Classroom-based assessment: conceptions and practices of secondary mathematics teachers]. Unpublished master's thesis, Universidade de Brasília, Brazil.
- Askew, M., Brown, M., Rhodes, V., Wiliam, D., & Johnson, D. (1997). *Effective teachers of numeracy: report of a study carried out for the teacher training agency* (Tech. Rep.). London: King's College, University of London.
- Black, P.J. (1993) Formative and summative assessment by teachers. *Studies in Science Education*, 21(1), 49–97.
- Black, P. & Harrison, C. (2001) Self- and peer-assessment and taking responsibility: the science student's role in formative assessment. *School Science Review*, 83, 43–49.
- Black, P., Harrison, C., Lee, C., Marshall, B. & Wiliam, D. (2003) *Assessment for learning: putting it into practice*. Berkshire: Open University Press.
- Black, P. & Wiliam, D. (1998a) Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice*, 5(1), 7–74.
- Black, P., & Wiliam, D. (1998b). *Inside the black box: raising standards through classroom assessment*. London: GL Assessment.
- Brookhart, S., Andolina, M., Zuza, M. & Furman, R. (2004) Minute math: An action research study of student self-assessment. *Educational Studies in Mathematics*, 57(2), 213–227.
- Butler, R. (1988) Enhancing and undermining intrinsic motivation: The effects of task-involving and ego-involving evaluation on interest and performance. *British Journal of Educational Psychology*, 58(1), 1–14.
- Cohen, L., Manion, L. & Morrison, K. (2011) *Research methods in education* (7th ed.). London: Routledge.
- Crooks, T.J. (1988) The impact of classroom evaluation practices on students. *Review of Educational Research*, 58(4), 438–481.
- Frohbieter, G., Greenwald, E., Stecher, B. & Schwartz, H. (2011) *Knowing and doing: what teachers learn from formative assessment and how they use the information* (Tech. Rep. No. 802). Los Angeles, CA: University of California: National Center for Research on Evaluation, Standards, and Student Testing (CRESST).
- Harlen, W. & James, M. (1997) Assessment and learning: differences and relationships between formative and summative assessment. *Assessment in Education: Principles, Policy & Practice*, 4(3), 365–379.

Harlen, W. (2004) *A systematic review of the evidence of reliability and validity of assessment by teachers used for summative purposes*. (Tech. Rep.). London: EPPI-Centre, Social Science Research Unit, Institute of Education.

Harlen, W. (2006). On the relationship between assessment for formative and summative purposes. In J. Gardner (Ed.), *Assessment and learning* (pp. 103–117). London: Sage Publications, Inc.

Hodgen, J. & Wiliam, D. (2006) *Mathematics inside the black box: assessment for learning in the mathematics classroom*. London: GL Assessment.

James, M. & Lewis, J. (2012) Assessment in harmony with our understanding of learning: problems and possibilities. In Gardner, J. (Ed.) *Assessment and learning* (2nd ed., pp. 187–205). London: Sage Publications, Inc.

Johnston, J. & McClune, W. (2000) *Selection project sel 5.1: pupil motivation and attitudes - self-esteem, locus of control, learning disposition and the impact of selection on teaching and learning*. (Tech. Rep.). Belfast: Department of Education for Northern Ireland.

Kelley, K., Clark, B., Brown, V., & Sitzia, J. (2003) Good practice in the conduct and reporting of survey research. *International Journal for Quality in Health Care*, 15(3), 261–266.

Lopes, C.E. & Muniz, M.I.S. (2010) *O processo de avaliação nas aulas de matemática* [Assessment process in mathematics classrooms]. Campinas: Mercado das Letras.

Pacheco, M.M.D.R. (2007) *Concepções e práticas avaliativas nos cursos de licenciatura* [Concepts and assessment practices in undergraduate courses]. Unpublished doctoral dissertation, Pontifícia Universidade Católica de São Paulo, São Paulo.

Perrenoud, P. (1998). From formative evaluation to a controlled regulation of learning processes: Towards a wider conceptual field. *Assessment in Education: Principles, Policy & Practice*, 5 (1), 85–102.

Popham, W.J. (2008) *Transformative assessment*. Alexandria: Association for Supervision & Curriculum Development.

Sebba, J., Crick, R.D., Yu, G., Lawson, H., Harlen, W. & Durant, K. (2008) *Systematic review of research evidence of the impact on students in secondary schools of self and peer assessment* (Technical Report No. 1614T). London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London.

Shepard, L.A. (2002) The role of classroom assessment in teaching and learning. In Richardson, V. (Ed.) *Handbook of research on teaching* (4th ed., pp. 1066–1101). American Educational Research Association.

Sirkin, R. M. (2006). *Statistics for the social sciences*. London: SAGE.

Susuwele-Banda, W.J. (2005) Classroom assessment in Malawi: teachers' perceptions and practices in mathematics. Unpublished doctoral dissertation, Virginia Polytechnic Institute and State University.

Valente, W. R. (2008). *Avaliação em matemática: história e perspectivas atuais* [Assessment in mathematics: history and current perspectives]. Campinas: Papirus.

Villas Boas, B.M.F. (2011). Compreendendo a avaliação formativa [Understanding formative assessment]. In *Avaliação formativa: práticas inovadoras* (pp. 30–42). Campinas: Papirus.

8. Appendix 1

Question 22: How often do you take the following actions after an assessment?	Rarely or never	Occasionally	Every time or almost every time
Q22.1: Record the marks and move to next topic	7.5% (25)	41.0% (136)	51.5% (171)
Q22.2: Provide review of all or part of the content using simplified example problems	6.3% (21)	54.8% (182)	38.9% (129)
Q22.3: Provide a review of all part of the content using students' solution attempts	8.4% (28)	46.4% (154)	45.2% (150)
Q22.4: Use the information from assessment to guide the assignment of additional work	5.7% (19)	30.7% (102)	63.6% (211)
Q22.6: Develop, using the information from assessment, different teaching strategies	3.3% (11)	24.1% (80)	72.6% (241)
Q22.7: Encourage students to find different studying plans	5.7% (19)	25.0% (83)	69.3% (230)
Q22.8: Use the information to tailor the teaching in an effort to build on perceived strengths	6.3% (21)	25.6% (85)	68.1% (226)
Q22.11: Use self-assessment or peer-assessment asking the students to analyse and revise errors and develop explanations or justifications of their own mathematical thinking	37.0% (123)	37.7% (125)	25.3% (84)
Q22.12: Provide written feedback on individual student work (e.g. notebook) without marking	27.7% (92)	43.7% (145)	28.6% (95)
Q22.13: Provide written feedback on individual student work and also a mark	23.5% (78)	44.9% (149)	31.6% (105)
Q22.15: Give the students the opportunity to discuss the different ways they used to solve particular problems	5.4% (18)	36.1% (120)	58.4% (194)
Q22.16: Provide students new opportunities to demonstrate their progress and/or their difficulties	6.3% (21)	33.7% (112)	59.9% (199)
Q22.17: Evaluate if the method of assessment worked	3.6% (12)	27.4% (91)	69.0% (229)

9. Appendix 2

Question 24: To what extent do you agree or disagree with each of the following statements?	Strongly agree	Disagree	Agree	Strongly disagree
Q24.1: All activities undertaken by pupils in the development of a particular content	0.6% (2)	7.2% (24)	38.0% (126)	54.2% (180)

should be evaluated.				
Q24.4: The assessment makes it possible to analyse the quality of instruction that is offered by the teacher.	1.8% (6)	23.8% (79)	51.2% (170)	23.2% (77)
Q24.7: Assessment is a motivation to students' intellectual development.	2.1% (7)	21.4% (71)	51.2% (170)	25.3% (84)