

TEACHERS' ASSESSMENT PRACTICES IN MATHEMATICS COURSES. DOES GENDER MAKE A DIFFERENCE?

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Assessment practices play an important role when technology is introduced in innovative mathematics and science teaching projects. Observation and interviews with teachers showed that even when they used the activities designed for the course, and their classroom practices were in accordance with the philosophical and didactical frameworks of the project, their assessment practices continued to be focused on traditional questions where the role of technology was not taken into account. This study focuses on gender differences in the way teachers assess their students learning and on what kind of information they consider important. Through a two- case study of teachers we discuss the main characteristics of the project, and contrast the differences observed between male and female teachers' approach to their assessment practices of student performance. We also discuss how these differences reveal the way they perceive the role of technology in their classroom, their students' attitude and their beliefs about science and mathematics learning.

Introduction

In 1997, a still ongoing national programme, the “EMAT” – Teaching Mathematics with Technology – Project was introduced by the Ministry of Education in Mexico. Its aim is to introduce technology (specifically, TI Calculators, Excel, Cabri-Géomètre, and Logo) in the lower secondary (children 12-15 yrs. old) mathematics classroom, together with a constructivist pedagogical approach that is specifically conceived to foster students' exploration, problem solving and whole class discussion. For each tool, national and international researchers in mathematics education invited to participate in the programme, developed student-centred activities, designed to foster exploratory and collaborative learning. Across the country and over almost a decade, teacher-training workshops have been held for the implementation in classrooms of each of the tools and of the pedagogical model.

There is a lack of research in gender issues in Mexico. Existing studies state that in the past there were fewer female students in mathematics related careers and that female researchers faced some difficulties in maintaining their required publication rhythm (Bosch, and Trigueros). More recently, studies have focused on high school students' achievement and attitudes towards mathematics when they participate in innovative projects involving technology (Ursini. 2006; Santos et., al, 2006; Ursini, et al., 2004). These studies have found no differences related to gender, although they report some other equity issues.

Literature on gender and mathematics throughout the world has also focused on students' learning and attitudes (Fennema, 1990; Forgasz & Leder, 1996; Kerr & Kurpui, 2004). There are few studies that focus on teachers' views on learning and their relationship to gender issues (e.g. Forgasz, Griffith and Tan, 2006). As teachers play an important role in favoring attitudes and learning conditions in their classrooms, and in providing contexts where both boys and girls feel more confident on what they are doing (Boaler, 1997), we consider that more studies related to the differences on

teacher's views and on teaching approaches that can contribute to create positive contexts in terms of gender equity are needed. This study intends to contribute in this direction.

Theoretical Framework and Methodology

The process of evaluation of EMAT can be considered as a research process in which there is a continuous effort of documenting and analysing the cognitive, affective and professional development of the different participants. The theoretical framework used is "research in design" introduced by Brown (1992) and Collins (1992) to describe a methodology for formative research on the changes in the development of teachers and students in the context of an educational environment. In this type of research creating a design that satisfies the purpose of the research is as important as the changes in the teaching and learning of the participants (Lesh, 2002; Kelly, 2003; Collins, et al., 2004; Carmona, 2004; Trigueros, 2004; Trigueros and Carmona, 2006). From this perspective, the design process involves multiple iterative cycles where all the participants' products of development, evaluation and refinement provide the data that can be analyzed to investigate the evolution of each of them from the point of view of different aspects of the project. All the documents collected during these cycles give enough information to understand the functioning of the educational context and of the design itself and to validate the results of the research. The methodology used involves qualitative analysis methods in order to find out the critical elements that play an important role in the educational environment throughout the different stages of its development.

For this research project we chose two teachers we were interested in looking at teachers' assessment practices. In particular we wanted to see how participation in the project affected teachers' approaches to assessment and if teacher's gender had an effect on how teachers perceive their students' progress when technology and a new pedagogical approach is introduced in the classroom. We designed a task where these teachers, one male and one female, who had been working since the beginning in the project and who showed competence with the use of technology and with the pedagogical approach, had to work through several cycles in a report where they had to document on EMAT students' learning. We complemented the cyclic work on the task with interviews with teachers and their students, and with class observation.

In particular the research questions we are interested in this paper are: Are there gender differences in the way teachers assess their students learning? What kind of information do they consider important?

Some results

We focus on the two case studies mentioned. In what follows we contrast the differences observed between male and female teachers' approach to their assessment practices of student performance. We discuss how these differences reveal the way they perceive the role of technology in their classroom, their students' attitude and their beliefs about science and mathematics learning.

Assessment practices of teachers

Observations show that Martha Works with computers in her class, children work collaboratively in small groups of four around the computer, they discuss freely and

have access to several textbooks where they can find responses to their questions. Martha walks around the class and answers students' questions. When Martha commented in the interviews about students' learning using computer activities, Martha emphasizes the importance of students' active involvement in solving the activities, she talks about the importance of the process of exploration in favoring students' thinking and on the possibilities that the activities favor students' self reliance on their own procedures and answers to questions that follow the exploration part of the activities. When asked about her assessment practices, she shows some concern. She is not sure what she has to take into account, although she considers participation and research abilities important, but she is not completely confident about what her students are learning in the class.

I: How do you assess your students?

M: uhm, well, I don't feel quite sure about this, I do tests, but I am never sure what to ask there and how to take results into account...for me it is important what they do in class, with the activities... but it how to ask something that has to do with that? Or how to take exploration or questioning abilities, or their discussion abilities? I don't know. I take participation into account...

She usually uses exams at the end of the month for evaluation purposes. When asked to show an example of exams, and to comment on a specific error of her students in those exams, it was found that exams are quite traditional, all questions have to do with the solution of specific problems or the repetition of a definition, and that all mistakes she remembers are related to definitions or procedures:

M: They have lots of difficulties when they have problems where they have to change units..., adding fractions is problematic for them, they really do not understand the concept of fraction,... the definition of linear function...in general applying factorization rules and some geometry definitions...

Martha showed a lot of enthusiasm and commitment while working on the task proposed by the researchers. She starts by making a chart where she compares her observations about students. In the first interview of the task cycles, she talks about how this chart helped her to analyze students' behaviors when they are working on the activities.

M: This is what I designed. In this chart I can take note quickly about what they are doing, what are their questions... when they say "I have it!", before, I just said "Fine!" now I ask them how they did it and make a not in my chart...then, after the class I can review it and I have an idea of what they did, their doubts, if explorations led to something...and even summarize their involvement, motivation...

She defines categories: student involvement, student interaction with others, students' autonomy, and results on tests. She also uses these categories to analyze past students behavior according to what she remembers, and talks about how making this chart helps her to determine how students' attitudes and knowledge had changed before and after the use computer activities in her class.

M: ... this I can review after each class, and even compare with what I remember happened before. I can use this to take more thinkg into account in my grade at the end of the period.

With this information she decides to focus on one student, Tenoch who she considers has experienced an important change in attitude and learning since using these activities. But she still doubts on how to assess this change.

M Well, you know that some students have changed, you can perceive it... You can see it in their faces and by their exclamations...but I understand you want me to give evidence... I don't know, that is difficult,...I have to think more about that...

Discussion with the research team in that session focuses on the importance of evidence in assessment, so for the next session she has to work on that. She decides to use her instrument to evaluate students' work while they are working in the activities and to compare different groups' answers to the questions to be able to determine differences in language and depth. She assigns points to the different components of the instrument to have a means to assess activities and take this work into account for grades at the end of the bi-month period. In order to follow Tenoch, she decides to interview him, some of his teachers in other subjects, his mother.

In the next interview she talks about how she is using her chart in assessment and how this has helped her to follow how students are learning instead of what they are learning, she talks about the importance of the learning process. She designs a new questionnaire for her students where some changes in focus can be seen from the original tests. She includes questions related to the activities and some questions about how they perceive their work in group and their own knowledge with the use of the computer activities.

M: One thing I have noticed is that I can use my chart better, I can follow how they are doing things and how they are learning. I have even changed some questions in my questionnaires and tests.

I: Can you show us a test?

M: I have this one. I added this question that has to do with the activity of taxi fares...and I included this question about the activity, to write another problem that can be solved the same way... also this about what they have learnt in the activities they have used in this period...

During the last interview she has written a report on how Tenoch attitude and performance has changed not only in her class but in other classes and at home as well. She notices how other students talk about him as an uninterested student who now likes work in class and takes the leadership in group work. She reconsiders her first instrument taking into account some of the items highlighted both by other teachers and the students when they were talking about Tenoch to assess students while working in class and adds participation in whole class discussion. Her last exam includes traditional questions and questions about attitude, self-perception, and questions clearly related to students' work on the activities and she took profit of a school visit to a park to ask students a report on where they could see mathematics in their activities in the park.

Interviews with Martha's students show that they like the work they do in the classroom. They appreciate the independence they have to make their own explorations and to look in the textbooks for possible answers to their difficulties. They say it was difficult for them to adjust to this class dynamics, they wanted the teacher to explain to them when they had a difficulty, but now that they are used to this methodology, they enjoy it because they are sure they learn more this way. In the last interview they talk about differences in examinations and how this was also difficult for them. They were not used to think about their work on the activities when they studied for the exam and had to rely on what they could remember. They all liked the experience about reflecting on their activities in the park. They feel they have learnt more in this course than in previous courses where work was more traditional.

“I like it a lot...at the beginning I wanted the teacher to explain to us, but working with the computer is fun... I feel I have learnt a lot, I read a homework problem and think so this is like such activity and usually can solve it, the teacher always asks us to think, it is not only a matter of memorizing...” (ESG 13, equipo 4)

Class observation data show that Jorge also works with computers but he always starts the class by explaining students what they will be working on in the activity, then children work collaboratively in small groups of five around the computer, they ask the teacher for help whenever they feel they need it, and he answers their questions using the concepts they need and explaining why, at the end there is a discussion period where Jorge asks questions related to the activity to individual students. During the interview Jorge showed concern about students’ learning using computer activities, he stresses that he has responsibility on their learning because they have to pass general examinations to continue their studies.

J: The problem is that I really don’t know what they have learnt now, I wonder what will happen, if students will understand the concepts or if they identify the concepts when they will need them... for example to continue studying they have to present tests and I feel responsible, they need to learn the concepts to give the right answer...

He comments on how his idea of what the meaning of learning is has changed since he is involved in the project, but he would like to have help to assess students’ knowledge. In particular he talks about the importance of students’ actions when working with activities and how this can help them to learn and use concepts. When asked about the purpose of the questions he asks at the end, he says he wants to know what students learnt and if each student really participated in the group work.

J: Because, before it was very important for me that they all know the definition, that was the way I know they understood. Now I think they have to understand first what they are doing and this understanding helps them to learn the concept and the definition.

He shows the researchers some samples of questionnaires he uses for assessment purposes. He uses traditional questions and problems. He is convinced that this is the only way to be sure of students’ knowledge, although he would like to include work on activities as part of the grade, because students’ responses to questionnaires do not reflect what he sees when responding to students’ questions, but he does not know how. He asks researchers for help in the definition of some parameters he can use in order to do this.

J: I need help with this, I have even discussed this with other project teachers in chat conversations. As I told you I see differences in students’ learning now when I compare this group with others I had before, but how to put them in black and white, that is the problem.

His answers to the role of computer use in learning reflect that he is not completely sure. He thinks work on computer activities helps because students have to face their own difficulties and because the computer gives feedback to them, he also claims using the computer will be an asset in students’ future because computer use is becoming more important each day.

J: Sometimes I don’t know, I think the activities and the computer help... the computer gives them feedback which is important, they know if what they are doing is right, they face their difficulties...I also think knowing how to use computers will be very useful for them in the future.. when they work, they can get a better job...

Jorge uses the computer in his class to communicate with other teachers working in the project. He comments that this communication has helped him to share experiences and ideas about how to work with his students, but, in the case of assessment practices he feels all the teachers have the same concerns and have not found a solution. He comments several times that he is not completely sure of his direction of the class in terms of students' learning.

J: Sometimes, I am not sure of what I am doing... I would like to know if what I am doing is really helping them to learn mathematics... I don't know how I could be sure about this.

When working on the task proposed by the researchers Jorge decides to report on two students: Citlaly who always show a lot of interest, and does well in questionnaires, and her answers and Xochitl who is a very introspect students who never asks questions and only looks at what other students do with the computer, without participating actively. When asked why he selected these two girls he says that he reviewed carefully the work of all the students, and that he thinks they have both progressed since they are using computer activities, and although there are boys who show some changes as well, it is more difficult to work with boys because they do not necessarily take the questions seriously and will probably not answer the full questionnaire he is planning to design. He designs a questionnaire dealing with fundamental concepts he thinks students should learn. He analyses the two students' responses and focuses more in the process they follow to work on the problem. He comments he now does not think that making mistakes in problem solving is as important as he thought before, because he can identify students' difficulties and work on them again in future classes.

J: ... Well, I still think problem solving is important, and I used to grade very strictly students' procedures and mistakes. Now I have realized that it is important for me to assess why students do the mistakes while solving the problem so I can help them by reviewing them in class and by giving them some more problems to work on.

During the second session, he considers the possibility to ask chemistry and physics teachers their opinion on how the selected students use mathematics in their classes as another way to assess students' learning. Communication with those other teachers convinced him of the importance to include other factors in his tests and in his grades.

During the last interview he shows researchers the questionnaires he has designed and how he has graded them. He shows how the grades of the two students have changed from the beginning of the class. He comments that even though Xochitl did not participate, she was attentive to the development of the activity and learning; also after working with him on the questionnaires she is participating more in group work. In his last report he includes comments on how his reflection on Citlaly and Xochitl's work helped him to realize that collective work and activities can help in students' understanding of important concepts and how he can take some of these aspects into account when he assesses his students, including questions where they have to apply their knowledge to new situations.

Jorge's students like working with activities and the computer. They like their teacher disposition to help them whenever they need it, and feel his responses are a key ingredient in their learning with the activities. They talk of the importance of computer feedback to be sure about their ideas and procedures. In the last interview they talk about how Jorge has changed in terms of his grading system and how their grades

reflect their work in activities. They feel they have learnt a lot in this course and feel sure about their possibilities to succeed in future courses even if they do not use the same teaching approach.

Ideas about the use of technology in their classes

Both teachers like using the project activities in their classes and are convinced that they are useful for students' development. Their perception of the role that these activities play are however quite different.

Jorge talks more about the role of computers' feedback in offering opportunities to students to make sure their ideas are correct. He also stresses that questions at the end of activities help students reflect on what they have done and to learn important concepts. For him the use of computers is very important because students learn how to use them in different contexts. This can be helpful in students' life once they have finished school since it can open new opportunities to them. He likes the fact that activities concern with models and real applications. He considers this can motivate students and help them realize that mathematics is useful to solve practical problems.

For Martha it is important that the use of activities with the computer focuses on exploration. She thinks this exploration is important to motivate students, but also to let students try different ideas and understand why some of them work while others do not. As Jorge, she thinks the use of real problems and models helps students realize the usefulness of mathematics in their lives, but she considers there are other reasons computers are important in her classroom. On the one hand she thinks that students develop good habits because they have to be responsible of their work and also of the computers, they have to take care of computers and be sure that everything is in order when they leave the classroom. On the other hand she considers that the use of activities has also helped her to think on other activities that complement what students have done with the computer and that can help students continue their reflection on their work in class.

Ideas of teachers about students' attitudes

For both teachers the use of computers in their classroom plays an important role in motivating students' work, they both tell the interviewers that their students like the class and like working with the computer. This information is confirmed by the results of the class observation and by the data from students' interviews. There are however some important differences between what each of the teachers observes in his or her students and about attitudes they consider young people should develop in school in general and in his or her class in particular.

Jorge observes that his students are more concentrated on what they are doing when they work with the activities, although he still considers there are differences between girls and boys because "*boys have a natural tendency to be more playful than girls*" and also because "*girls are more responsible and better workers than boys*". He considers that working with technology has helped to reduce anxiety and fear of mathematics both in boys and girls.

His comments are more centered on the importance of learning in general but in particular of mathematics and science for children to succeed in the future.

He considers that attitude towards mathematics is not different in boys and girls, and he is clearly concerned about giving all his students the same opportunities for learning. He considers that mathematical basic concepts have to be learnt at school and that applications are necessary to understand other subjects and also to apply mathematics in everyday life. For him, the activities provided by the project fulfill this goal.

Martha's interviews and report show her concern about children's positive attitudes. She considers that giving autonomy to her students is an important part of the use of technology in class, she feels students have to learn how to learn and that facing some challenges and applying mathematics to everyday activities can help them "discover the joy of learning". She thinks working with technology also makes the children aware of their importance for their future development, but her interest is clearly oriented towards making students feel that mathematics is only part of what they have to learn to become better persons and citizens. She stress the need of responsible attitudes towards work. She is also concerned about students' attitudes on respect to others and self responsibility.

Ideas of teachers about mathematics and science

The way both teachers talk about the role mathematics plays in understanding other subjects and on the importance of mathematics to succeed in the future. Both of them see mathematics as becoming more and more important in every aspect of life.

When asked about why they thought so, they linked mathematics to understanding different scientific and social phenomena, to be able to think better, to understanding problems and being able to think about their solution.

Both of them consider applications and the use of technology to accomplish the formative character they assign to mathematics.

The only important difference found between both teachers was that Jorge emphasizes the importance of learning mathematics while Martha considers important that students learn and enjoy doing mathematics. For Martha using imagination and creative is also very important in science and mathematics.

Many of the ideas expressed by both teachers were related to the importance of mathematics and science in society. Both linked them with possibility of success in the future, and both stress that mathematics was a practical subject since it could be used in many applications and in real-life contexts.

Some conclusions

The results obtained from these two case studies show that, throughout their involvement in the EMAT project, both teachers modify their ideas about the learning of mathematics in important ways. Their beliefs and opinions, however, show interesting differences.

Martha's conceptions on learning mathematics became increasingly complex. As she reflected on her own work in the classroom and on students' behaviours, she started to incorporate a variety of elements which became important when thinking about students' learning. She emphasized that several aspects such as students' attitudes and beliefs, language, understanding, independence and autonomy were important components of learning. She started taking all these issues into account when thinking

of assessment practices. The role of computers in students learning was, for Martha, that of exploration. This is important because exploration enabled students to be more independent. Creativity and imagination were also considered by Martha to be important elements to take into account when discussing students' learning. Her emphasis of students being able to enjoy the learning experiences gives additional evidence to the multifaceted character of learning that Martha developed.

Jorge's views on learning also changed. He kept, however, a pragmatic view which focused on student's ability to learn and understand mathematical concepts. Learning processes became increasingly important for Jorge, but he saw himself as having the main responsibility for the outcome of those processes. The role of the computer was, for him, to provide feedback for students, and its use was also important because of its relevance on student's future. He was mainly concerned with students' being able to use mathematics in different contexts and also with their ability to continue their education.

It is not possible to generalize from the differences that were observed in this two-case study, however, research carried out on the EMAT project included a large number of teachers and it is possible to observe general tendencies that differentiate female from male teachers. As in this study, female teachers tend to have a more global perspective when thinking about students' learning, including emotional, social and cognitive aspects. Male teachers tend to focus mainly on the learning of mathematical concepts and procedures and about the use of this learning in real life.

As this study shows there seem to be important differences in the way teachers approach their job. As other studies show, there are differences in opinions between female and male teachers on the use of technology in class (Forgasz, Griffith and Tan, 2006). We have shown here that this is also the case for the teachers studied, but we have also shown that there are other differences that may play a role in creating a positive learning and development environment.

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