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Identifying a Gender-Inclusive Pedagogy from Maltese teachers' personal practical knowledge

Abstract

Teachers bring with them into the science classrooms their own gendered identitities and their views and perceptions about how boys and girls learn and achieve in science. This paper tries to explore the way in which 14 Maltese science teachers use their own 'personal practical knowledge' to identify their views about gender and science and create their own individual gender-inclusive pedagogy. The study suggests that the science teachers focus more on the individuality of students and on the social and cultural background of the students in their classrooms rather than on gender. The teachers try to develop pedagogies and assessment practices which take into consideration the personal constructs of individual learners. The ideas for such a gender-inclusive pedagogy emerge from their common-sense experience in the classroom, their training as teachers and are closely interrelated to current ideas of social constructivism.

Introduction

Teachers bring into the science classroom a complex web of experiences, skills, habits, values, talents, perspectives and interests (Cole & Knowles, 2000), including their own personal gender identity as well as their gendered expectations for the students in their classrooms. These gendered identities or the attitudes and views about what is believed to be expected behaviour for a boy or for a girl are developed through socialisation within particular groups and communities and are part of the culture we inherit (Murphy & Whitelegg, 2006a). Teachers are often positioned as "gender-neutral or always objective, negating the ways in which teachers' own values and beliefs enter into their constructions of gender relations" (Allard, 2004, p. 347). However, research suggests that: teachers perceptions of gender differences can affect the way they interact and communicate with pupils (Gray & Leith, 2004); teachers construct behaviour along gendered lines (Allard, 2004) and that teachers project social representations of gender

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onto boys and girls (Ivinson & Murphy, 2004). There is an inextricable link between the personal identity of the teacher and the professional, what the teacher does in practice (Connelly & Clandinin, 1990).

Within the setting of the science classroom the social representation of gender is more pronounced. Murphy (1990) argues that "how students interact with science also depends on the image of science which is represented to them in their culture. The uniformity of gender differences across countries gives support to the contention that science has a masculine image in many countries" (p. 2). Kelly (1985) states that there are at least four distinct areas in which it can be argued that science is masculine. The most obvious is in terms of numbers – who studies science at school, who teaches it, who is recognised as a scientist. Secondly, there is the packaging of science, the way it is presented, the examples and applications that are stressed. Thirdly, there are the classroom behaviours and interactions whereby elements of masculinity and femininity developed in out-of-school contexts that are transformed in such a way as to establish science as a male preserve. Finally, there is the suggestion that the type of thinking commonly scientific embodies an intrinsically masculine view. As children, science teachers were exposed to this masculine view of science, and our gendered experiences, all contribute to who "we are and what we believe and do as educators" (Cole & Knowles, 2000, p. 28). These social representations of gender are "actively reconstructed through the activities of teachers and students…classroom settings therefore present students with an edited version of the gender arena" (Ivinson & Murphy, 2006, p. 92).

In this paper I wanted to explore teachers' views and perceptions of gender in relation to learning, achievement and teaching in science. Current debates in gender and science education focus mainly: on differences in performance between boys and girls in examinations (Elwood, 2005; Elwood & Murphy, 2002); on the choices of science subjects in secondary school (Cleaves, 2005); on women opting out of science careers (Blickenstaff, 2005); and, on feminist perspectives of learning science (Brickhouse, 2001). There has been little emphasis on research into teachers' views and perceptions of gender differences in science and how teachers construct their pedagogies in relation to

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gender. "Teachers are positioned by governing discourses but also work to shape these shared truths" (Allard, 2004, p. 359). The more we understand a teacher's 'personal practical knowledge' (Connelly & Clandinin, 1988, p. 25) the more we can understand teaching and learning in a gender-inclusive manner. I wanted to explore the extent to which teachers themselves understand their own personal constructs of gender identity and whether their views about learning and achievement in science influenced the way they taught science. As pointed out by Roger and Duffield (2000) "teachers who become aware of their own sex-stereotyped behaviour and who are willing to change it can make a difference" (p. 371). I focused on the teacher because following Cole and Knowles (2000) I believe that "it is impossible to understand teaching without understanding the teacher; that it is impossible to understand the practice apart from the practitioner; that it is impossible to understand the knowledge apart from the knower" (p. 9). I wanted to give voice to the teachers' own views in order to engage the teachers in interrogating aspects of their teaching and learning in order to bring to the consciousness, knowledge that may or may not have been realised even though acted upon (Lyons, 1998).

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The Research

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In May 2006 I was the main lecturer responsible for a masters level module entitled *Inclusivity and diversity in science learning.* The M.Ed. (Science Education) was offered by the University of Malta using materials produced by the Open University. The main aim of this module was to examine science teaching and learning from a socio-cultural perspective. The focus was on identifying alternative contexts for learning science and using exemplars from practice to develop an approach towards a pedagogy which meets the needs of all students, what Hodson (1998) describes as 'a unique learning context' (p. 83). The module was delivered as a series of four three-hour seminars. The postgraduate students who enrolled in the course were all practicing science teachers. During the seminars they engaged in discussions regarding culture, gender, science for all, and inclusive education. They brought with them to these seminars "a view of knowledge with attention to practice" (Lyons & LaBoskey, 2002, p.11). Their 'personal practical

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knowledge' (Connelly & Clandinin, 1988, p. 25) formed part of the foundations of what they believed to be their own personal philosophy of teaching and learning.

I was keen to explore the ways in which these teachers were constructing their own meanings of gender and how they were looking to their past experiences to think and rethink their teaching strategies and pedagogies in terms of gender. In the stories and examples of practice the teachers were sharing with colleagues I could see a view of their knowledge as being socially and culturally constructed within the local context of Maltese secondary schools. Their knowledge was situated in their own meanings of experience (Bruner, 1996). From the discussions carried out in the M.Ed. seminars, I realised that these teachers knew a great deal about what was working and what was not working with the girls and boys they were teaching in their science classrooms. I wanted to make the experiential knowledge and exemplars of practice which the teachers were sharing with each other in the seminar forum more explicit and visible. Like Elwood and Klenowski (2002) I believed that postgraduate students construct their meaning of gender in relation to science from their learning experiences. However in the masters course they were also being exposed to new ideas about gender and they were actively making sense of new knowledge presented to them in order to develop their own pedagogies of teaching and learning science. Their understandings of how they were responding to gender issues in the science classroom were being shared and this enabled them to become part of 'a community of shared practice' (Elwood & Klenowski, 2002, p. 246).

I therefore decided to work with the teachers and through their narrative knowledge explore gender-inclusive practices in a number of Maltese science classrooms. The study was not intended to document all that was happening in Maltese science classrooms. As stated by LaBoskey and Lyons (2002):

> Teaching involves the active engagement of human beings with one another in the interest of learning. It is therefore complex by nature, unpredictable and context-specific. We cannot aim to discover final answers or magic recipes. We can endeavour to develop exemplars that can provide frameworks for meaningful

inter-exchange and thereby make powerful knowledge construction more possible (p. 197).

Method

The methodology used in the study was based on the premise made by Lyons and LaBoskey (2002) that "narrative practices can serve as exemplars, models of inquiry for others to try in their own settings" (p. 11). Because the study was based on the views, beliefs and ideas of teachers like Denzin and Lincoln (2005) I wanted to "…stress the socially constructed nature of reality, the intimate relationship between the researcher and what is studied, and the situational constraints that shape inquiry" (p. 10). Like Griffiths (1998) I started from the premise that "all facts and information are value laden...and that knowledge gets its meaning from the political position of the knower" (p. 46). The steps of the research followed von Eckartsbery (1986, cited in Moustakas, 1994) where first I identified the research question I wished to explore, secondly, I obtained the data through descriptive narrative provided by the teachers who were viewed as co-researchers and engaged in dialogue; and thirdly, the data was analysed by reading and scrutinising so as to reveal their structure, meaning configuration, coherence and the circumstances of their occurrence.

The teachers who collaborated in the research were the 14 teachers enrolled in the M.Ed. (Science Education). The teachers came from the different types of secondary school in Malta (Table 1): Independent schools which are fee paying schools run by Parents Foundations and are co-educational schools; girls' and boys' Church schools run by the Catholic Church; and State Schools which include girls' and boys' Junior Lyceums which cater for those girls and boys who pass an examination at eleven years and girls' and boys' Area Secondary Schools for students who fail their examination at eleven years, or do not sit for the 11+ exam. Both Junior Lyceums and Area Secondary Schools are single sex schools. The teachers also had a variety of experience teaching girls and boys (Table 2). Some had taught only girls or only boys, some taught in a mixed school and some had experience teaching both boys and girls.

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Following the interactive discussion on gender in one of the M.Ed. seminars I contacted the teachers by email and asked them to participate in the study. A conversation was initiated in which the teachers were asked to respond and give feedback by email regarding their views on whether they thought that there were any differences in the ways in which girls and boys learn science, whether girls and boys achieve differently in science and why they thought that girls and boys learnt and achieved differently or not in science. The teachers were asked to base their responses on their own personal experiences as science teachers, they were left free to respond to these questions in an open-ended way. Following the email correspondence a one-to-one semi-structured interview was held with all the 14 teachers. In the interview open-ended semi-structured questions were asked. The questions probed in further depth the issues which the teachers had raised in their written feedback. Teachers were asked to give more detailed examples of their practice. The aim was to obtain personal and concrete data rich in examples from practice (Connelly & Clandinin, 1988). I tried to use both written feedback obtained by email as well as data obtained from interviews in order to obtain a multiple perspective of what the teachers were saying. While the email correspondence established a link with the teachers and got them thinking about the issues, the one-to-one interview enabled me to engage in what Fontana and Frey (2005) describe as face-to-face interaction. I used these two methods to present a more holistic, more entwined and interrelated narrative of the research process (Richardson, 2005).

During my conversations with the teachers, both by email as well as in the one-to-one interviews my interest was always in "understanding the experience of other people and the meaning they made of that experience" (Seidman, 1991, p. 3). I could also develop a relationship of trust with the teachers. I myself had been a science teacher and knew some of the teachers as colleagues. Furthermore, as a University lecturer I had taught some of the teachers when they were undergraduate students. However, I tried to emphasise that they were collaborators in the research. " The research was a joint construction not transmission of knowledge and was characterised by negotiation, feedback and respect for each other" (Cole & Knowles, 2000, p. 197). I constantly

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stressed that the intention of the study was to build a shared understanding to continue the discussions initiated in the masters seminars. The teachers were asked to participate in the study on a voluntary basis. They all chose to participate since they all had a great deal to say about their classroom practice and felt that through their conversations with me they could give voice to what they felt they had learnt from their own classroom practice and experience and relate it to the new knowledge they were being exposed to in the masters course.

Data obtained from the self-narrative of teachers can be considered to be problematic because it can encourage discourse of a confessional genre leading to self-deception and lead to power relations where the participants try to please the interviewer because they perceive the interviewer to be more powerful than themselves (Lyons & LaBoskey, 2002). I tried to overcome this by ensuring the participants that all that they said would be treated with confidentiality and that I viewed them as collaborators in the research. The data was obtained at the end of the module after the teachers had received their assessment so they did not feel that their contribution to the study would influence the grade obtained in the course. Like Cole and Knowles (2000) I realised that "the deep relationship of trust and respect I built with the teachers helped me to safeguard their interests and to critique and reflect on my actions" (p. 196). The knowledge gained from the conversations held with the teachers were not meant to be generalisable or universal, they were simply meant for the learning of the teacher. The teachers were already knowledgeable about gender issues since they had been involved in courses about gender at undergraduate level as well as at masters level. They were already encultured in the discourse of gender equity but most of this discourse was embedded within what they believed to be knowledge gained from their actual experience in the classroom. I hoped that in the process of collaborative inquiry, the narratives of teacher practice would allow me, like Griffiths (1998), to work with the teachers in order to explain and give reasons for how teachers develop a gender-inclusive pedagogy.

When I had the transcripts of all the email correspondence as well as the transcripts of the one-to-one interviews I read and re-read them in order to start to establish themes and

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patterns which started to emerge from the data. Using the model adopted by Delamont (1992) I developed several categories and started to fit the data into these categories. These categories were then searched for what Seidman (1991) calls patterns and connections within the categories described as themes. A manual system of cutting and pasting the data (Hammersly & Atkinson, 1990) was then used in order to construct a conceptual scheme which then enabled me to interrogate the data and start writing the text of the teachers' narratives. In this process I did not distinguish between information obtained from the written feedback by email and the interview transcripts. I felt that both had to be treated in the same manner when developing the categories and units of meaning. "The meaning or meaning units are listed. These are clustered into common categories or themes, removing overlapping and repetitive statements. The clustered themes and meanings were used to develop the textual descriptions of the experience. This is then integrated into meaning" (Moustakas, 1994, p. 119). This resulted in what Denzin (1994) calls a "multi-voiced, reflexive, open-ended, emotionally based text" (p.510).

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The text which emerged used the views of the teachers as they challenged traditional ways of learning and teaching science. The teachers actually shared examples from their own practice and talked about their own personal views and beliefs based on their current practice as science teachers. They did not talk about what they thought they should do or should be doing, they talked about what they were actually doing. The teachers' views on achievement in science and learning science were related to current international research. The exemplars of teacher practice which came from the data were then used to document a gender-inclusive pedagogy based on the teachers' own personal and practical knowledge.

Challenging traditional ways of learning and teaching science

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The theoretical framework which guided this study emerged from readings in social constructivism and feminist critiques of science education. They emerged from the basic tenet that "scientific knowledge is gendered" (Brickhouse, 2001, p. 283) and that

"teaching, learning and assessment are gendered processes" (Elwood & Comber, 1995, p. 3). Constructivist theories of learning suggest that students come to science with concepts and ideas about science which they have developed from their everyday learning experiences. They then need to rethink and reconstruct their ideas and views to fit in with scientific explanations of phenomena. "Constructivist approaches generally involve creating opportunities for students to make their own ideas explicit, share them with others, subject them to critical scrutiny and test their robustness by observation and/or experiment" (Hodson, 1998, p. 35).

As learners construct knowledge within the science classroom they are not only constructing knowledge which is only scientific in nature, for example Newton's Laws of Motion, or how an electric circuit is formed or how photosynthesis takes place. They are also constructing knowledge about what is expected out of them as males or females, what is acceptable behaviour in science for boys and what is acceptable for girls. They are also developing their own views and expectations of how boys and girls achieve in science and the legitimate career opportunities which are open to males and females. Ivinson and Murphy (2003) state that:

> As students participate in classroom practice they experience gender as a range of social possibilities or constraints about what they can legitimately say, do, write and behave as a boy or as a girl, as they attempt to realise the skills, know how and practices that make up subject-knowledge…Hegemonic social representations of gender may be reinforced, challenged or transformed through classroom practice (p. 92).

As teachers we pass on conscious or unconscious messages about what is expected out of the different genders in science.

Teachers' views of gendered differences in achievement in science

The teachers who participated in the study were asked to give their views on whether they thought that girls and boys performed differently in science. This was considered

important since as argued by Gray and Leith (2004): "teachers perceptions of gender differences can affect the way they interact and communicate with pupils" (p. 9). A similar argument is made by Murphy (1997) who states that: "the expectations of teachers have been found to have a direct impact on students' beliefs about their competence" (p.12). Other research (Elwood, 2005) shows how teachers' expectations influenced girls' performance in science. Elwood describes how boys in a co-educational setting in comparison with girls were seen to be relatively self-assured, anxiety free and unperturbed by exams. Girls on the other hand were perceived to be more motivated and conscientious. Gipps (1996) also shows that boys' failure tends to be attributed to something external to them (poor teaching, inappropriate method) while girls' failure is attributed to something in them (their intellect or their work). In science, Allard (2004) suggests that, "the valuing the female less, regardless of performance (whether academic or social) is common and suggests that particular discourses around gendered differences remain in place" (p. 355). The teachers who participated in the study did not seem to think that girls in Maltese schools were being valued less. This could be due to the fact that in Malta most schools are single sex schools and only three out of the 14 teachers who participated in the study taught in a co-educational school. In fact four teachers out of 14 thought that girls performed better in science and another four teachers that boys performed better in science. The other six teachers thought that there was no gender difference in achievement. The teachers who had the perception that girls performed better in science examinations thought that the girls performed better because they are more meticulous in their work and study harder. As stated by a teacher from a girls' Church school:

> *…girls are more organised and persistent in their studies. They work harder and manage to get better results in exams…it doesn't mean that they know more science…they are more meticulous in their work and make less mistakes attributed to carelessness…they also put in more effort…*

This is similar to observations carried out by Elwood (2005) who states that "we still observe teachers and examiners attributing girls' successes not to their brilliance but to

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hard work and industry" (p. 383). Elwood and Carlise (2001) also suggest that girls are better prepared than boys when it comes to examinations. They argue that:

> the superior performance of females on science papers may well be explained by them being better prepared and organised; they are more familiar with the conventions and requirements of the science topics in the syllabus, they have learnt the content that is focused on the tests and they can recall these as required to do so in questions. Boys, on the other hand are generally less well organised than girls and less well prepared for examinations, preferring to take risks on the day (p. 109).

The teachers who perceived that boys perform better in science examinations, thought mainly that the boys performed better because of the way in which they respond to questions in the end of the year examination. A female teacher from a boys' Area Secondary school attempts to explain why in Biology boys are performing better than girls. She suggests that:

> *…boys tend to achieve higher scores because in Biology they have to give concise answers with specific key words. I also feel that the majority of boys are more capable of analysing data and comprehension questions. I believe that Paper 1 is a difficult paper and girls tend to perform badly because they are less able to extract what the examiner is requesting and give and answer which is straight to the point…*

The view of this teacher corresponds to findings by Murphy and Whitelegg (2006a) who state that physics teachers also thought female students had more difficulty than males applying knowledge and understanding and in designing and planning experiments. It is also similar to findings by Bell (2001) who shows in his research that there are gender differences in the retrieval of declarative knowledge and depth of processing information which influences the way in which girls and boys respond to examination questions. In Malta, Sammut and Vassallo (2006) report that boys tend to answer questions short and to the point while girls prefer to write in paragraphs and at length.

A number of teachers (six out of 14) believe that there is no gender difference in achievement between boys and girls. This belief is predominant in the teachers who teach in a co-educational school. For one of these male teachers:

> *…In my current situation I don't think they do. It is a matter of ability. I have boys and girls who achieve very well because they are highly motivated, and have a high ability. But then I also have both boys and girls who are either not at all interested or who have extremely low learning abilities…*

The teachers who participated in the study were very strong in their view that there are many differences among the students whom they taught and the differences were not only based on gender. This indicates a complexity in the nature of the factors which influence assessment and achievement which cannot be attributed to a single factor and leads to the argument made previously (Ivinson & Murphy, 2003) that learning, assessment and achievement cannot be viewed outside their social context. As stated by a male teacher from a boys' Junior Lyceum:

> *…I believe that both can achieve high. I've been teaching for some years in a boys' Junior Lyceum and I've noticed that a class is made up of different individuals. Each individual has his own abilities, motivations, problems, etc. and at the end it's the teacher's job to highlight their abilities and help them tackle their problems in the subject. During my short experience teaching girls, I had the same feeling. I believe that one has to adapt to the type of students s/he had in front of her/him…*

Gender and Learning

Brickhouse (2001) describes learning in the following way:

> Learning is happening all the time – whenever a person engages in activity in the world. Learning is unavoidable. It is what is required in the process of becoming a person. Learning is not merely a matter of acquiring knowledge, it is a matter of deciding what kind of person you are and what you want to be and engaging in those activities that make one part of the relevant communities (p. 286).

For Brickhouse (2001) we learn not only subject and content knowledge but also what is expected of us as members of a particular community and leads to the development of a personal and gendered identity. For the majority of the teachers who participated in the study (10 out of 14) boys and girls learn science in a different way. They believed that "children are not only channelled into gender appropriate experiences but also into gender specific ways of experiencing. As a consequence children may not only have different experiences, but also different expectations and approaches to learning" (Murphy, 1991, p. 208).

The differences in learning identified by the teachers (Table 3) range from differences in self-confidence, differences in kinaesthetic and visual intelligences, to differences in out of school interests and study habits.

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The portrayal of boys as more active in science, more risk taking, more involved in the relevant context is similar to what is reported by Elwood and Carlise (2001) who suggest that boys prefer to take risks while girls are more prepared and organised. Elwood and Comber (1996) also illustrate that teachers' description of female ability and patterns of learning are attributed to ideas of diligence and hard work while boys are considered to have more flair, originality and sparkle.

What seems to be important for the teachers who participated in the study is that boys like to participate more in the lessons and prefer lessons in any of the science subjects which are more hands-on. A teacher from the girls' Area Secondary school says:

> *I find girls to be more passive in their learning. For example during a practical session boys take the lead and want to do the experiment themselves while the girls have to be pushed to get them to handle the apparatus themselves. They prefer a demonstration and then make the write up on their lab books. In general girls are less confident to try out and solve problems on their own especially if they have to do calculations…*

Other teachers (four out of 14) seemed to think that the different learning patterns of boys and girls can be attributed to the predominance of different types of intelligences associated with girls and boys. This is stated by a female teacher from a boys' Junior Lyceum:

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> *…I have more experience with boys, however I still believe that there exist differences in the way boys and girls learn science. Boys tend to be more kinaesthetic, more hands-on, more spatial-mechanical. They tend to learn more when the teacher begins the lesson with a practical example and then come up with the theory behind that example. On the other hand I think that girls learn the other way around. This means that they understand more when the teacher begins by explaining the theory and then introducing more practical examples involving that theory at the end of the explanation…*

For one teacher who teaches in a boys' Junior Lyceum however the focus of difference should not be only on gender but on the cultural baggage which the students bring with them into the classroom. For this teacher:

> *...I believe that every student comes to class with a cultural baggage that makes her/him different from the other student sitting next to her/him. Students are different because they differ in family background interests, aspirations, experiences, language and a multitude of other factors…I don't agree with those who simply say girls study more and are keen to work hard while boys like more the practical aspect of the subject but are lazier when it comes to study and work. Although some might fit in these descriptions, I've met different students that definitely do not fit these widely believed stereotypes…*

Intuitively, from their experience as well as from their exposure to discussion relating to gender theory in their masters course, the teachers seem to be subscribing to a socio-cultural perspective of learning where learning and teaching "build on the cultural capital and know-how that students bring with them into classrooms" (Ivinson & Murphy, 2003, p. 109) and the "appreciation of the uniqueness of personal learning contexts" (Hodson, 1988, p. 83). In the words of a male teacher from the girls' Area Secondary school:

> *…From my experience of teaching physics and chemistry to boys and girls in the same classroom for nine years I do not think that there are gender differences in the learning of science. What I observed were differences in student interests. Some enjoyed one topic more than another topic. Some chose to write about one project, others chose a different project. I had both girls and boys obtaining very good marks and others obtaining less good marks. Some girls and boys were emotionally disturbed and could not learn. But there was no gender difference in this either…*

The point which these teachers seem to want to make is that there are many differences within the same classroom but these differences are 'ordinary differences' (Chetcuti & Griffiths, 2001) and do not necessarily need to be treated as problematic. The differences become problematic only when we treat them as such, and when we try to exclude individuals from academic or career opportunities depending on their gender, culture or ability. As stated by one male teacher from a girls' Church school:

> *There are much more differences between members of the same gender than between opposite genders…*

Developing a gender-inclusive pedagogy from personal practical knowledge

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The idea for this paper emerged from the theoretical framework described in the introduction that teachers very often develop a pedagogy of teaching and learning based on their 'personal practical knowledge' (Connelly & Clandinin, 1988, p. 25). I believed that "practical experience is an authorative component of teacher knowledge" (Cole & Knowles, 2000, p.7). What emerged out of the data is that the teachers who participated in the study had constructed their own pedagogy of teaching and learning science . This development of a gender-inclusive pedagogy on the basis of teachers' classroom practice is not meant to be a universal truth. Rather it is meant to show how from personal experience teachers can develop professional knowledge. This professional knowledge evolves from the interaction of practice, teacher-training and the construction of personal understanding through on-going reflection and evaluation. "Making sense of prior and

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current life experiences in the context of the personal as it influences the professional is the essence of professional development" (Cole & Knowles, 2000, p. 15). Also the exemplars of practice which emerged from the data are highly contextualised and relevant to the current situation, students and personal context of the teachers who participated in the study. The teachers are also a highly select group since as masters students they are highly motivated and interested in engaging in dialogue to improve their practice. As argued by Cole and Knowles (2000):

> The examples we cite are but snapshots of teaching experiences bounded by time and context. The meanings we derive from the examples are but part of our ongoing sense making. With different students under different circumstances the same pedagogical approaches might be differently interpreted and have different meanings for us and them (p. 195).

From my analysis of the data, in their narratives of practice the teachers suggest a number of key principles for an effective gender-inclusive pedagogy which can cater for individual differences. In my view these principles are very similar to a feminist perspective of science learning, which aims to "change conventional hierarchies between teachers, students and subject matter…(and) attempts to give more consideration to students' ideas and needs than traditional teaching" (Brickhouse, 2001, p. 283). This attempt to give more considerations to individual student needs is expressed by a female teacher from a boys' Junior Lyceum:

> *…I believe that there exist much more differences between boys and girls themselves than between the sexes. In a group of boys there are more differences than one can actually find between a boy and a girl. Every one of them is unique and different from other persons. After all in a class of 25 boys every boy learns in his own personal way…*

The six key principles described by the teachers are:

Teaching and learning should cater to individual needs

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The teachers who participated in the study focus on the individual needs of the students and finding strategies to cater for all the diverse needs of students. All the teachers state that in some way or another they try to adapt their teaching according to the students they have in front of them. As described by a female teacher from a girls' Area Secondary School:

> *..the majority of my students are of a low ability and have a very short concentration span so during the lesson I try to change activity as frequently as possible. I also try to keep examples very simple and put concepts in contexts that they can understand. Most of the students have problems with language and because of this I try to use Maltese to explain* (in Maltese schools text books and examinations are in English and although teachers are expected to teach science in English, many teachers use code-switching and Maltese to teach because some students are Maltese speaking and find it difficult to follow a lesson in English)*...I try to use visuals such as transparencies and videos and also group work and discussions so that I try to cater for those student who do not like to write...*

This is similar to a gender-inclusive pedagogy described by Hildebrand (1996) who describes a pedagogy which values: (a) prior experiences and learning; (b) current interests, needs and concerns; and (c) preferred learning and assessment styles. Hildebrand (1996) argues that there is no such thing as value-free gender, value-free science or value-free assessment. Our values and social context are implicit in all the choices that we and our students make. This is why it is important to take into consideration the experiences of students and their needs and to also provide multiple learning and assessment strategies for them. The individual needs of students are also emphasised by Parker and Rennie (2002) who state:

> ...a supportive learning environment which emphasises communication, interpersonal negotiation, interaction amongst all participants, harassment

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free discussions, active participation by students; second, real-life contexts; third, school-based, informal assessment procedures, with relatively open-ended tasks drawing on contexts which are familiar to both boys and girls; and fourth, attention to the students' self-awareness of the extent to which their education related decisions and experiences are socially constructed…The pedagogy and assessment procedures should take account of the diverse ways of knowing, viewing and describing the world (p. 882).

Provide for different learning styles.

Learning takes place in a participation framework as part of ongoing activity in a social context (Lave & Wenger, 1991). Therefore to learn about science requires students to participate in the practices of science in which professional scientists engage, what is known as culturally authentic science learning (Murphy, Lunn & Jones, 2006). In order to cater for these different learning styles as suggested by Bancroft (2002), we need to use multi-sensory teaching strategies and multi-sensory assessment tools. This can be done through practical, oral, drama, creative writing, and use of ICT. This will ensure that all the different talents and ways of learning, of students are taken into consideration. As described by a male teacher in a girls' Church school:

> *…I try to alternate between different styles of teaching so that I can reach different learning styles. I use both dictation of notes and handouts, examples with and without contexts, use auditory or visual aids, and encourage everyone all the time to try out different things so that they do not feel that they do not know something…*

Use relevant contexts.

The teachers who participated in the study all stated that they try and make use of contexts which are relevant for both boys and girls, but the choice of context depends more on the background and culture of the students they have in front of them. For one male teacher from a girls' Area secondary school:

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> *…I try to help students to relate to the topic more. For example when explaining how to wire a plug, I always tell the girls to learn how to do it, 'do you need a male to wire an electric plug for you?' and to the boys… 'You surely know how to wire a plug!'…Example ultrasound uses I will obviously mention seeing the baby in the mother's womb but I will also give other examples such as to find the depth of the sea or as used by some animals to locate themselves…but I use all the different examples with both the boys and the girls…I do not use particular examples only for boys or only for girls….*

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Bancroft (2002) also suggests the use of imaginative contexts which motivate and engage pupils as they prepare for learning. The use of context as 'an organiser for science content' and a 'problem situation' is important for students to see the authentic relevance of what they are learning in science (Murphy, Lunn & Jones, 2006). Research has shown that what is relevant for girls might not be relevant for boys, and a study by Murphy and Whitelegg (2006b) suggests that girls are more likely than boys go want an emphasis of social application. However, I would agree with Murphy, Lunn and Jones (2006) who argue that if the social situations are challenging enough then boys' interest in science learning is also enhanced.

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Use role models and narratives of scientists.

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Murphy, Lunn and Jones (2006), suggest that authentic science learning needs to model the real life practices of scientists. Brickhouse (2001) takes this idea a step further and argues that a new vision for science education could reshape the character and nature of science and this can only be done if students are presented with role models and narratives of scientists including modern day scientists who have moved away from the traditional norms of practicing science. The teachers who participated in the study all state that presenting students with a historical perspective of science is an important way of enculturing students into new ways

of thinking about science. A female teacher in the boys' Junior Lyceum shares her own examples from practice:

> *I use pictures of male and female scientists doing experiments…I also mention discoveries by both male and female scientists…I also like to use examples from cooking even though I teach boys but most of them are still interested in cooking…I ask them why a turkey is covered in foil while cooking...Role models are also important for example it helps a lot that we have both female and male teachers who teach science…*

Use the principles of assessment for learning such as such learning goals and giving qualitative feedback

The way in which we assess students, the assessment tasks we choose, and the context of the questions chosen all influence the performance and achievement of students. "Assessment tasks have social consequences… (which) manifest themselves in the form of differential performance between different sub-groups" (Elwood & Murphy, 2002, p. 396). In my view like Gipps (1994), I would argue that "assessment does not stand outside teaching and learning but stands in dynamic interaction with it" (p. 15). This view is also stated by the teachers who participated in the study. A male teacher from a boys' Junior Lyceum talks about the way in which he uses the principles of assessment for learning (Black & Wiliam, 1998) such as constant questioning, self-assessment and qualitative feedback:

> *I mostly believe that in order to cater for the individual needs of students I have to get a better understanding of the students' background. To do this I use a pre-test to get a general understanding of the students' knowledge in a particular topic…This helps me get a good idea of the different individuals. I then use the gathered information to plan my future lessons and identify how each individual student can be assisted. I continue this throughout the year by discussion and questioning and constantly giving the students feedback…*

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The main focus is on "assessment for learning (assessment whose purpose is to enable students, through effective feedback, to fully understand their own learning and the goals they are aiming for)" rather than on "assessment of learning (assessment for the purposes of grading and reporting with its own established procedures)" (Elwood & Klenowski, 2002, p. 244). This form of formative assessment supports and enhances learning and encourages achievement irrespective of differences among students be it due to gender, race, culture, religion or ability.

Valuing difference among individual students

In the classroom, the teacher has to be aware not only of the academic abilities and achievements of students but also differences which can lead to them being marginalised and left out of the science learning community. The classroom pedagogy of science needs to "place considerable importance on caring student teachers relationships and attend not only to the intellectual needs of students but also to their emotional needs" (Lyons, 1990, p. 283). In the view of a female teacher who teaches in a boys' Junior Lyceum:

> *My concern apart from trying to develop teaching examples which are of interest to the boys I am teaching is how to cater for 'someone who is different' as they find it very difficult to integrate with the other students and because of this their performance is very poor. For example I always have some boys every year who seem to have a different sexual orientation (the way they move, talk and wear their uniform makes it obvious)…These boys are not usually accepted in the classroom and the only strategy I can think of to integrate these students is to continually remind the other students that they should be treated with respect and not judged for their sexual orientation…*

As stated by Murphy (1991) "many children will have meanings, and contexts and experiences in common but treating them as a homogeneous group is not appropriate in a constructivist paradigm" (p. 213). We need to accept and respect

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diversity and in order to do this we need to know our students and "who they are and who they want to be" (Brickhouse, 2001, p. 286).

Conclusion

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The teaching practices which have been narrated in this paper are examples of "the experiential knowledge that is embodied in us as persons and is enacted in our classroom practices and in our lives" (Clandinin, 1993, p. 1). As I set out to discuss with teachers their views on how girls and boys achieved and learnt science and how teachers catered for gender differences in their own classrooms, I started to hear another story. The teachers who participated in the study were not pre-occupied with gender. Although they did their best as shown in the data to cater to the different views and interests of boys and girls they were more concerned with the individual needs of each student in front of them. One reason for this could be the fact that most of the teachers who participated in the study teach in a single sex school. The diversity of students in front of them was a major issue. They were concerned with trying to find a pedagogy which would cater for these differences and yet allow all students in their classrooms to be successful.

While the emphasis on individual difference is a laudable approach since it focuses on the personal knowledge of students and unique learning contexts which have been the basic ideology running throughout this paper, it is also dangerous to eliminate gender from any discussion about catering to the diverse needs of students. Elwood (2005) argues that although alternative approaches to learning, teaching and assessment such as the ones discussed in this paper are welcome alternatives when it comes to practice we must be cautious of accepting everything as having a positive effect on boys and girls. She continues to stress that in any alternative pedagogies or alternative assessment processes then gender and any other equality dimensions still need to be taken into consideration. Similarly Brickhouse (2001) also argues that "a feminist perspective on learning should account for ways in which gender shapes learning" (p. 290). The teachers who participated in this study are saying the exact opposite. Like Wenger (1998), the teachers seem to be suggesting that the focus of science learning, teaching and

assessment should be on the individual but it should also include social structures. The danger with this is that although they are supporting a gender-inclusive pedagogy in principle their classroom practices in fact continue to support the traditional dichotomies between male and female. This is one of the limitations of the present study which focused only on the views and perceptions of teachers and did not observe practice. What teachers say that they are doing can actually be very different from what they actually do in the classroom.

In the end, in order to ensure a gender-inclusive or as can be redefined a socially constructed pedagogy of teaching science based on situated and interactional cognition, the responsibility of the teachers lies in making explicit their personal constructs so that through reflection they can constantly evaluate and re-evaluate practice. "Understanding oneself as a teacher is foundational in the initial and ongoing development of professional practice" (Cole & Knowles, 2000, p.25). It is only through reflection that the complexities of teaching can be captured and changed. It is only from snapshots of prior experience that we can move on and develop new teaching pedagogies which will ensure fairness for all the students in our science classrooms. "This narrative knowledge becomes publicly visible leading to transformative changes in practice" (Craig & Olson, 2000, p.115). Teachers' images of experience and exemplars of practice are an important starting point for exploring how students are perceived to understand and learn science. This is a means for teachers to engage with their own subjectivities and come to know why they are doing what they are doing. It is also a means for collaborative reflexive inquiry, which helps us to understand how to provide the best opportunities for learning and successful achievement for all the students in our science classrooms and transform our practice.

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Table 1: Type of School of respondents

Type of School	
School	**No. of teachers**
Independent	3
Girls Church School	2
Boys Church School	1
Girls Junior Lyceum	1
Boys Junior Lyceum	4
Girls Area Secondary	2
Boys Area Secondary	1

Table 2: Teaching experience of respondents

Teaching Experience	
Students Taught	**No. of teachers**
Girls only	4
Boys only	4
Co-educational	5
Taught both boys and girls	3

Table 3: Differences in learning science between girls and boys.

Difference in the ways in which girls and boys learn science	
Boys	**Girls**
More confident	Less confident
More out of school experiences in science	Less out of school experiences in science
Competitive, take the lead	Not so competitive, passive
Like to actively carry out practical work	Prefer to observe demonstrations
More impulsive and risk taking	Work harder and more meticulous
Find science relevant	Find science more abstract
Can work independently	Need to be helped more
Grasp concepts immediately	Need to be helped more visually
Prefer hands on kinaesthetic activities	Prefer to listen more to explanations
Learn better when numbers are involved	Do better in topics with no mathematics

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