

Paper prepared for the OECD Expert meeting on Gender, ICT and Education, Oslo 2-3 June, 2008, on the topic **“ICT(s) and socialization: The role of the school and teachers”**

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1. The gender gap in attitudes and beliefs about ICT

A large number of international studies has overwhelmingly revealed significant gender differences in young people's attitudes and self-efficacy beliefs about ICT. Females tend to be less interested in computers, to have less positive views about the value of computing, and to report more computer anxiety and less confidence in their computer abilities (Volman & van Eck, 2001). The gap in self-efficacy is fairly consistent from the elementary school (Meelissen & Drent, 2008; Nelson & Cooper, 1997; Vekiri & Chronaki, 2008) to university (Cassidy & Eachus, 2002; van Braak, 2004) and has been observed even in high-achieving female computer-majors enrolled at prestigious academic institutions (Singh, Allen, Scheckler, & Darlington, 2007). Value and self-efficacy beliefs have a significant effect on the quality of student engagement, learning and performance and are important predictors of both males' and females' current and future academic choices (Dickhäuser & Stiensmeier-Pelster, 2003). High-efficacious and interested learners respond positively to challenge, expend effort, use cognitive and self-regulation strategies (Pintrich & DeGroot, 1990) and, as a result, they are more successful academically and prepare themselves better for future academic and career pursuits (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001; Eccles, 1994). Understanding some of the possible causes and the factors that are linked to gender differences in self-efficacy and interest in computers can help us consider effective educational interventions and clarify the questions that need to be addressed in future research.

2. Why is that? Possible interpretations of gender differences in ICT attitudes and beliefs

A number of environmental and social factors, such as early exposure to computers, access to computers, frequency of computer use, parental and peer support for ICT learning, have been found to contribute to a positive image of oneself as technology user and to interest in developing expertise (Cassidy & Eachus, 2002; van Braak; Vekiri & Chronaki, 2008), and have been used to explain differences in boys' and girls' attitudes and beliefs about ICT. As research in educational psychology has documented (Pintrich & Schunk, 1996), self-efficacy is mainly affected by learner's interpretations of their past experiences, by external support from others and by access to successful role models. Success in past experiences builds confidence in competence, which in turn encourages children to take on new challenges. At the same time, experience helps children develop knowledge so that they respond successfully to new challenges. Young people are exposed to ICT at an early age and spend a lot of their time using ICT, often in the context of family and peer activities. Boys are likely to begin using computers earlier than girls and they more likely to have access to same-gender role models. They are also more likely than girls to have access to a computer at home, to use computers on a daily basis, to use computers in the context of peer activities, to attend computer clubs and courses outside school, and

to receive more encouragement from their parents to improve their knowledge about ICT (Tømte, 2008; Vekiri & Chronaki, 2008; Volman & van Eck, 2001).

In addition to examining differences in experience and social support, there have been some attempts to link gender differences in attitudes to cultural stereotypes about gender and ICT (Funk & Buchman, 1996; Newman, Cooper, & Ruble, 1995). Children get exposed to such stereotypes from their early years, while interacting with family members, peers, and the media. Research shows that many parents espouse stereotypes about the abilities of women in gender-typed domains (Jacobs & Eccles, 1992). These views are reflected in parents' behavior (Tenenbaum & Leaper, 2003) and children are able to perceive them (Shashaani, 1994). Not only video and computer games but also highly-rated educational software are characterized by an overrepresentation of male characters who exhibit "masculine" traits, and contain activities based on masculine stereotyped actions such as violence and competition (Chappell, 1996; Sheldon, 2004). Exposure to cultural stereotypes, in turn, appears to affect children's own views about gender and technology: about gender appropriate behaviors and preferences, differences in females' and males' abilities, and attributions about what makes someone good or bad at computers. Many students are likely to believe that working with computers is more typical for men (Newman et al., 1995) and that certain behaviors, such as electronic game playing, is more appropriate for boys (Funk & Buchman, 1996). Students recognize software as masculine or feminine and show preference for those that they think are intended for their own gender group (Pinkard, 1995). Young people, typically more boys than girls, tend to think that boys are generally better at computers (Oosterwegel, et al., 2004; Vekiri & Chronaki, 2007). What is interesting here is that, while girls tend to disagree with stereotypes, boys perceive computers as a masculine domain. Further, in boys stronger stereotypes were found to correlate positively with higher interest in ICT and with more positive beliefs about the value of ICT (Newman et al., 1995, Vekiri & Chronaki, 2007). As Facer et al. (2001) observed, for boys developing computer expertise appears to contribute to the construction of their gendered identities.

Whether students' perceptions of gender differences in computer performance are accurate or not is not the only issue that should draw attention. Students' interpretations of these differences have equal or even higher importance. Girls tend to attribute their successful accomplishment of computer tasks to hard work or luck and failure to lack of ability (Nelson & Cooper, 1997; Voyles, & Williams, 2004). Boys, on the other hand, are more likely than girls to attribute their success to their ability and failure to lack of effort or bad luck (Nelson & Cooper, 1997), a pattern also identified in studies of student beliefs in other gender-typed academic domains (Stipek & Galinski, 1991). Students' interpretations of successful computer performance are consistent with prevailing stereotypical images of computing and the *geek mythology* (Margolis & Fisher, 2002): computing requires "masculine" qualities such as rationality and the ability for abstract and mathematical thinking and is associated with characteristics that are typically perceived as incongruent with the female nature, such as asocial behavior and a narrow focus on programming to the neglect of everything else (Singh, Allen, Scheckler, & Darlington, 2007). According to these stereotypical views, being good at computers comes naturally to boys as the result of innate abilities and characteristics, however, females have to work hard to succeed. According to psychological research on student attributions (Pintrich & Schunk, 1996), such perceptions will have negative consequences for females' self-

efficacy and future engagement with ICT. When failure is attributed to lack of ability, repeated unsuccessful experiences will hurt girl's confidence and reduce the possibility to take on future challenges that could help them become more competent. In their study Nelson & Cooper (1997) found that girls expressed less positive views about their computer abilities after unsuccessful computer experiences while boys' confidence was not affected.

Unfortunately, many educators espouse such stereotypical views about males' academic success in ICT-related fields, and reinforce these views with their teaching practices. In their ethnographic study of learning environments in postsecondary computer science courses at a U.S. institution, Barker & Garvin-Doxas (2004) observed that many professors referred to good programmers as people who were "smart". Such practices communicate the message that becoming successful is a matter of innate ability and not the result of accumulated experience. When experience is equated with intelligence, females who tend to have less programming experience are less likely to view themselves as potentially good programmers. Attributions might help us explain the "we can; I can't" paradox (Makrakis, 1993), that is, the fact that although girls tend to disagree with stereotypes about their gender, they have less positive views about their competence than boys: "other girls might be good at computers but I am not inherently intelligent and there is nothing I can do about it".

Stereotypes may cause anxiety and pressure that can undermine performance, even in individuals who do not espouse stereotypes and do not have doubts about their abilities. This phenomenon is called *stereotype threat* (Spencer, Steele, & Quinn, 1999) and can appear in situations where females need to demonstrate their competence in male-typed domains, such as math examinations, where they are expected to perform according to dominant stereotypes about their gender. Stereotype threat can be triggered even by subtle contextual factors that remind girls of their gender identity, such as the gender of participants in a group activity. Inzlicht and Ben Zeev (2000) found that high-achieving female students had equally successful performance on a math test compared to their male peers when they worked in single-sex groups but their performance declined in mixed groups and the decline was proportional to the number of males in their group.

3. What can teachers do?

3.1. Motivate the New Millennium Learners

Several longitudinal studies on motivation (Midgley & Edelin, 1998, Ryan & Patrick, 2001) have established strong connections of students' self-efficacy to certain elements of the classroom environment. In particular, students' perceptions of their academic competence is enhanced when teachers foster a "mastery-orientation" to learning, that is, when they focus on student learning and improvement, communicate positive expectations to the students, view mistakes as opportunities for learning, encourage collaboration and recognize effort and individual progress. On the contrary, self-efficacy deteriorates when teachers adopt a "performance" orientation, that is, when they place heavy emphasis on student performance and highlight student achievement differences (i.e. when they provide praise and recognition to some students only or announce and discuss student grades in public). Practices that encourage competition and social comparison may benefit high achieving students but

are detrimental for students with average or low achievement and more vulnerable perceptions of their competence. While mastery-focused classroom environments communicate the message that individual differences are valued and that all students can learn and improve, performance-focused environments communicate the message that only some students are able to learn and succeed.

Interest and value beliefs are enhanced when teacher practices encourage active learning and collaboration, provide opportunities for student control, choice, and decision-making, and when tasks are characterised by novelty, are challenging and have closure (Malone & Lepper, 1987). These are elements of project-based, inquiry-based and problem-based teaching and learning approaches (Blumenfeld et al., 1991). Based on current cognitive, sociocognitive, and constructivist theories of learning, these approaches require that students work collaboratively on authentic problems and questions that evolve from their own interests and are meaningful to them, plan investigations, integrate information from a variety of sources, and create artifacts to demonstrate what they have learned. In this process teachers need to guide and support students so that intermediate tasks become manageable, and students are cognitively engaged and able to succeed.

These constructivist and mastery-focused pedagogical approaches are more compatible with the everyday world of the new millennium youth (Pedró, 2007), their identities as learners and their needs as future citizens. ICT learning outside school is characterised by student control, choice and decision making. Students work on tasks that they have chosen because they are challenging, important or useful to them and relate to the real world. They decide how to approach them and how to allocate their time and resources. They gather information from a variety of sources and often get help from other people (peers working on similar problems or experts). They need to use self-regulation to monitor their progress and achieve their goals. Finally, students are engaged in these activities not because they are forced to do so but because they have a “mastery orientation”: they are intrinsically motivated to learn and develop competence. Constructivist, learner-centered, mastery-focused approaches can prepare NMLs better for the challenges of adult life, as they can help them develop skills for life-long learning (National Research Council, 2000). Young people can learn how to evaluate and synthesize information, to collaborate with others on joint projects, to tackle complex everyday problems, to regulate their own learning, and to understand the process of knowledge construction in different domains.

This is different from the everyday classroom reality of many countries in Europe, North America and around the world, where the prevailing teaching approach is the “knowledge transmission” model: students typically work alone; they work on tasks whose purpose and value is not readily apparent because they are not usually relevant to students’ everyday lives; they work on highly-structured problems that are different from the ill-structured problems they will later encounter as adults in the real world; and they need to depend mainly on the teacher and the textbook for information. This approach has been found to cause a decline in student motivation (Midgley & Edelin, 1998) and to result in *inert* knowledge (National Research Council, 2000).

3. 2. Motivate equally boys and girls

While there is plenty of evidence to suggest that “progressive” pedagogical approaches can enhance self-efficacy and interest, certain elements of these approaches may not work the same for boys and girls. One such element is student collaboration. When it comes to ICT learning, research shows that boys and girls have different preferences, and adopt different collaboration approaches. Boys enjoy working alone and prefer to discover things on their own, while girls prefer to collaborate and to share what they learn with others (Barbieri & Light, 1992, Ching, Kafai, & Marshall, 2000, Volman, van Eck, Heemskerk, & Kuiper, 2005). Observations of students during ICT collaborative activities indicate that boys tend to be task-focused and to ignore group processes while for girls it is equally important to discuss what they do and to resolve interpersonal conflicts (Ching, Kafai & Marshall, 2000).

These differences can be used to explain why, as several studies have shown, boys and girls tend to work better in single-gender groups. Underwood, Underwood, & Wood (2000) found that single-gender groups exchanged more questions and explanations about the task and Edwards, Coddington & Caterina (1997) observed that female-only groups were more likely than male-only or mixed groups to negotiate ideas in order to develop a common plan of action. Female groups make more fair use of the mouse, while in mixed groups boys want to control the mouse and the keyboard (Barbieri & Light, 1992, Fitzpatrick & Hardman, 2000, Underwood & Underwood, 1998, Underwood, Underwood, & Wood, 2000). In single-gender groups students are more likely to discuss their disagreements and to try to reach consensus, while in mixed groups boys are likely to force their ideas on the girls (Fitzpatrick & Hardman, 2000).

While collaboration with boys does not usually have negative effects on girls’ immediate performance (Barbieri & Light, 1992, Light, Littleton, Bale, Joiner, & Messer, 2000, Underwood, Underwood, & Wood, 2000), it may have long-term consequences on their self-efficacy and attitudes. In a year-long study which focused on boy-girl interactions during science laboratory activities, Jovanovich & King (1998) found that boys tended to use equipment and materials more often than girls while girls were forced by the boys to assume assistive roles (i.e. note taking), and this resulted in a decline in girls’ self-efficacy and interest in science at the end of the school year.

Teachers need to be aware of practices that may encourage or permit a gendered labor division and limit girls’ cognitive and physical access to learning resources in the classroom. They also need to be aware of gender differences in prior experience, preferences, interests, and learning approaches and to differentiate instruction in order to respond to the needs of various groups of students. There is a need for more studies to examine which specific changes in the learning environment (content, materials, instructional techniques) can contribute to positive attitudes and achievement for girls. Empirical findings so far indicate that many aspects of school learning, including subject-matter content, materials, teaching approaches, and practices are oriented towards boys’ interests and needs. Textbooks, children’s books, and educational television programs contain more male than female characters as successful role models with which students can identify (Volman & van Eck, 2001). Girls prefer

software that involve female characters, adventure, creative scenarios and problem solving, without elements of competition and violence (Volman & van Eck, 2001; Volman et al., 2005) but most of the available educational software contain male characters in stereotypical roles and elements of competition or violence (Chappell, 1996; Sheldon, 2004). Girls are more interested in the applications of ICT to the solution of problems rather than on the technical aspects of computing, which is often the focus in introductory information science courses. And teachers tend to interact more with boys than with girls and to allow boys more participation in classroom discussions (Aukrust, 2008; Duffy, Warren, & Walsh, 2001).

There are examples in the literature showing that gender differences in computer performance can decrease or disappear when the design of the learning environment takes into account individual differences in student interests and learning approaches. In their study, Ching et al. (2000) achieved equal participation of boys and girls in a collaborative software design project, after making changes in the “social” and the “physical space” of the classroom, in order to target gender differences in students’ collaboration styles. These changes included group discussions that enabled students to address group conflicts and a re-arrangement of the available technological resources that permitted girls to maintain contact with their female colleagues. Joiner, Messer, Littleton, & Light (1996), who developed a “female” (in which the main character was a princess) and a “male” version (in which the main character was a prince) of the same adventure game, found that girls scored higher in the version that they preferred, which was usually the one with the princess.

3.3. Challenge stereotypes about gender and ICT

Teachers have their own views about how ICT should be integrated in teaching and learning, boys’ and girls’ ICT-related abilities, the qualities that characterize students who get on well with computers, and the factors that cause the gender gap in computers. There is little empirical research on elementary and secondary teachers’ beliefs about gender and technology as well as on the way teachers interact with boys and girls in the context of ICT learning activities. Studies in the field of mathematics, however, show that teachers tend to have higher expectations for boys and to think that boys are more capable in mathematics (Li, 1999). In their study of elementary school teachers in the U.S., Fennema, Peterson, Carpenter, & Lubinski (1990) found that teachers tended to attribute boys’ successes and failures to ability and girls’ successes and failures to effort. Teachers seemed to associate mathematical ability with certain traits which were more typical for boys, and this was reflected in their descriptions of their best boy students as “more competitive, more logical, more adventurous, and more independent in mathematics” compared to their best girl students.

Research shows that teacher expectations affect student achievement and that girls in male-typed domains such as mathematics are more susceptible to teacher underestimates of their ability (McKowin & Weinstein, 2002). However there isn’t much empirical data on *how* teachers communicate expectations and tacit assumptions about gender and ICT, and, alternatively, on which teacher practices are effective in fostering non-stereotypical views about boys’ and girls’ relationship with ICT.

It appears that one key element in students' and teachers' gender schemata is the belief that computer ability is a fixed entity, a characteristic determined by genes, which no action on girl's part can change dramatically. Educational psychologists (Pintrich & Schunk, 1996) recommend that teachers should foster in students the belief that competence or ability is changeable and controllable and that expertise in any domain develops with experience, effort, persistence, and use of good learning strategies. This can be accomplished when teacher practices focus on the *process* rather than on the *product* of learning and problem solving, for example when teachers explain and model good learning strategies and when they invite class discussions where students' approaches to a particular problem or assignment are thoroughly analyzed and evaluated.

The review of the literature shows that there is more research on the "gender gap problem" rather than on solutions that work. There is a need for empirical data that will link particular teacher practices to changes in boys' and girls' stereotypical views about ICT and gender and to improvements in girls' self-efficacy and attitudes. What becomes evident is that, as significant socialization agents, teachers are part of the solution and, to some extent, part of the problem. Thus, future interventions need to involve teacher professional development. Teachers need to become aware of their own stereotypes and their impact on the way they relate to students.

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