Journal of Vocational Behavior 80 (2012) 486–499

Contents lists available at SciVerse ScienceDirect

Journal of Vocational Behavior

journal homepage: www.elsevier.com/locate/jvb

Self-concept of computer and math ability: Gender implications across time and within ICT studies

Milagros Sáinz [a,*], Jacquelynne Eccles [b]

[a] Internet Interdisciplinary Institute, Universitat Oberta de Catalunya (UOC), Roc de Boronat 117, 7th floor, 08018 Barcelona, Spain
[b] Research Center for Group Dynamics, Institute for Social Research, 420 Thomson Street, P.O. Box 1248, Ann Arbor, MI 48106, USA

ARTICLE INFO

Article history:
Received 18 April 2011
Available online 31 August 2011

Keywords:
Gender
Math ability
Computer ability
Math performance
ICT studies and achievement

ABSTRACT

The scarcity of women in ICT-related studies has been systematically reported by the scientific community for many years. This paper has three goals: to analyze gender differences in self-concept of computer and math abilities along with math performance in two consecutive academic years; to study the ontogeny of gender differences in self-concept of computer and of math abilities and math performance across subject areas; and to contrast the role these variables play in predicting ICT-related studies over 2 years. 900 (M = 15 years, *s.d.* = 1.73) and 424 (M = 16 years, *s.d.* = .49) Spanish secondary students participated at both times. Self-concept of computer ability is higher in boys at both times; furthermore it decreases in girls and increases in boys across time. At time 2, boys have a higher self-concept of math ability, despite the lack of gender differences in math performance. Participants have a higher self-concept of math ability and math performance at time 1 than at time 2. Self-concepts of computer ability predict the intention to pursue ICT-related studies and mediate the association of gender with the intention to pursue ICT-studies.

1. Introduction

Boys are more likely to develop an interest in the physical sciences and engineering than girls; in contrast, girls are more likely to develop an interest in biological and social sciences, languages and reading than boys (Eccles et al., 1998). These different preferences in boys and girls become more intense during the secondary school years, the time in life when adolescents must choose school subjects and academic paths. Several studies have shown that such choices are influenced by such psychological factors as their hierarchy of interests, ability self-concepts and domain specific self-efficacy beliefs, and the perception of costs and benefits of getting involved in different activities (Bandura, Barbaranelli, Caprana, & Pastorelli, 2001; Deci & Ryan, 1985; Eccles, 1994; Eccles & Wigfield, 2002).

International researchers have systematically reported that women are more likely than boys to aspire to careers in health and biology-related careers. In contrast, men are more interested in pursuing scientific and technological studies and less interested in studies related to the provision of care and nurturance (Eagly & Wood, 1999; Eccles, 1983; 2007; Kiefer & Shih, 2006). In the Spanish context, technological studies are prestigious because, among other different aspects related to their inherent work opportunities, they are associated with high intellectual capacities and are very difficult to enter because they require high academic performance in technological and scientific domains, such as math, physical science or technology (López-Sáez, Puertas, & Sáinz, 2011). For this reason, some authors have analyzed why girls are not as interested as their male counterparts in pursuing these challenging and highly prestigious studies, despite having good academic qualifications to obtain admission in them (Eccles, 2007; Eccles, Barber, & Jozefowicz, 1999). Those students who are not good at those technology-related domains or perceive that they are not competent enough at those domains (like women) may not choose them, even if their real performance in those domains is not as low as they perceive it be (Bandura et al., 2001; Eccles, Adler, & Meece, 1984).

* Corresponding author. Fax: +34 93 450 52 01.
E-mail addresses: msainzi@uoc.edu (M. Sáinz), jeccles@umich.edu (J. Eccles).

0001-8791/$ – see front matter © 2011 Elsevier Inc. All rights reserved.
doi:10.1016/j.jvb.2011.08.005

1.1. Factors explaining the lack of female enrollment in science and technology-related studies

Mathematical abilities are considered a prerequisite for those students wanting to enroll in technological studies and those who want to gain admission to the related college majors and professional occupations (Meece, Eccles-Parsons, Kaczala, Goff, & Futterman, 1982). For this reason, those students excelling in math-related subjects in secondary are the ideal candidates for advanced technology and science related degrees. It has long been argued that boys are more likely to have mathematical talent than girls while girls are more likely than boys to have verbal talent, leading boys to do better in mathematics than girls, to develop high math ability self-concepts, and to be more likely to enter math related technical fields (Eccles et al., 1998; Guimond & Roussel, 2001; Skaalvik & Skaalvik, 2004). However, the validity of this explanation has been called into question by the meta-analytical research of Hyde, Fennema, and Lamon (1990). These authors found little support for the assumption that boys, on average, demonstrate higher mathematical abilities than girls.

The most recent PISA report published (OECD, 2010) shows that the girls, on average, performed somewhat worse than males in mathematics in many countries, but the advantage of males in those countries where this difference exists was mainly due to the very high levels of performance of a comparatively small number of males. Overall, gender differences in mathematics were less than one-third as large as for reading, 12 points for mathematics versus 39 points for reading on average across OECD countries. This pattern has not changed since PISA 2003. The lack of interest of boys in reading has an impact on their perception of their own reading abilities and the choice of studies. As a result, boys are less likely than girls to pursue these studies and therefore remain underrepresented in these fields (Kiefer & Shih, 2006).

More recent research supports the gender similarities hypothesis assuming the existence of more psychological similarities than differences between men and women in different domains and abilities (Hyde, 2005; Hyde & Linn, 2006). Nonetheless, the context can create, minimize, or increase the effect of psychological gender differences (Bussey & Bandura, 1999; Eagly & Wood, 1999; Hyde, 2005). In this sense, there is also evidence on how cultural and situational contexts can exacerbate the magnitude of gender differences in academic performance (Eccles, 1983; Hyde & Linn, 2006; Meece et al., 1982). In addition, according to the theory of Stereotype Threat women may perform less well than men on standardized tests (such as SAT-Math or the PISA math test) not because they have less math ability than men but because of the anxiety produced by stereotype threat (Spencer, Steele, & Quinn, 1999).

Despite the fact that the gender differences when present favor males on competitive tests of math ability, girls in general get better grades than boys in mathematics courses and the proportion of females majoring in mathematics per se (rather than the physical sciences, engineering and technology) matches that of males in some countries, such as the USA (Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002). For example, in Spain women made up 50.09% of the undergraduates seeking a university degree in Mathematics in 2006–2007 (Instituto de la Mujer, 2010). This pattern of equal participation of women in the university degree of mathematics has remained constant for more than 10 years ago. Thus, it is not clear that mathematics per se is stereotyped as male. Early studies in the USA, for example, found that mathematics was one of the least gender-stereotyped subject areas (Huston, 1983). More recent studies suggest that most children, particularly girls, indicate that neither boys nor girls are more likely to excel in mathematics (Ruble, Martin, & Berenbaum, 2006). So perhaps it is not the stereotype of mathematics per se that is negatively influencing girls' performance on tests of mathematical skills, but rather stereotypes associated with the physical sciences, technology, and engineering.

In support of this suggestion, research provides ample evidence that women consider themselves less competent in technology-related domains (despite their high performance in these domains) and that this belief can deter them from participating in technology-related studies (Creamer, Lee, & Meszaros, 2006; Eccles, 2007). For this reason, both between and within individual differences in self-perception of domain abilities are very predictive of which academic subjects individuals are likely to pursue (Deci & Ryan, 1985; Eccles, 1983; 1987; Marsh & Yeung, 1997).

The Expectancy-Value *Model of Achievement Choices* formulated almost 30 years ago by Eccles-Parsons et al. (1983) continues to be one of the most prominent motivational theoretical frameworks in which both self-concepts of domain ability and the subjective task value attached to various achievement-related choices play a major role in the explanation of motivational factors leading to behavioral outcomes, like the choice of studies and careers. These authors suggest that individuals' achievement-related choices are directly influenced by expectation of success and subjective task value (Eccles, 1987; 1994; Eccles-Parsons et al., 1983; Wigfield & Eccles, 2002). Therefore, individuals may value more those tasks at which they think they can excel than those tasks at which they are unsure about the likelihood of success and for this reason they may be more likely to enroll in courses and studies that they think they can master and that have a high task value for them.

The model links achievement-related beliefs, outcomes and goals to interpretative systems like causal attributions, to the input of social agents (e.g., parents, teachers, siblings, peers, and media), to various social-role related beliefs, to self perceptions and self concept, and to one's perceptions of various tasks, behaviors and activities themselves (Eccles, 2007). Hence, self-concepts of domain-specific abilities result, at least in part, from the feedback provided by other significant people. The influence of family, school, peers, mass media and immediate social environment shapes men and women's self-concept of their own abilities together with the value they attach to various subjects and academic domains (Eccles, 1994).

Encouragement received from other significant people (family, schools, peers and others) to pursue math and technology-related studies plays a major role in whether adolescents decide to pursue a career in those domains or not (Bandura et al., 2001; Eccles et al., 1999; Hackett, 1999; Sáinz et al., 2009; Zarrett, Malanchuk, Davis-Kean, & Eccles, 2006). In this sense, self-concept of math ability has been considered a crucial factor in the analysis of the lower participation of women and other minorities in math-related studies (Eccles, 1984; Hyde et al., 1990). Gender differences in self-beliefs mediate gender differences in selected achievement behavior (Fredricks & Eccles, 2002).