Commentary on the Chapter by Anastasios Barkatsas, "Students' Attitudes, Engagement and Confidence in Mathematics and Statistics Learning: ICT, Gender, and Equity Dimensions"

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Barkatsas' chapter contributes to the discussion on gender issues in the affective aspects of learning statistics (using SATS) and learning mathematics with ICT (using MTAS). My response to the chapter has two parts: contributions of the findings to the original theoretical basis of the instruments, and implications of the studies on equitable policy and practice.

Since the studies provided evidence of the validity and reliability of both the MTAS and the SATS instruments, a next step would be to investigate how the findings of the studies relate back to the theoretical basis of the instruments.

1 Theoretical Basis of MTAS

The development of the MTAS was based on a hypothesised model described by Pierce et al. (2007) in relation to the use of technology to enable more real world problem solving in the mathematics classroom. In the hypothesised model, using a real world problem solving approach driven by technology could lead to increased affective engagement (AE) and mathematics confidence (MC), which in turn would lead to increased behavioural engagement in class (BE) and improved learning. A positive attitude to learning mathematics with technology (MT) could result from the positive learning experience and outcome, which in turn would influence future learning experiences with technology. Other factors supporting technology use such as confidence in technology (TC) were also described in the model. The MTAS was developed to measure five components in the model (AE, MC, BE, MT, and TC).

Although Barkatsas' findings are just a snapshot of the situation, rather than repeated studies or a longitudinal study, I would like to argue that they could be used

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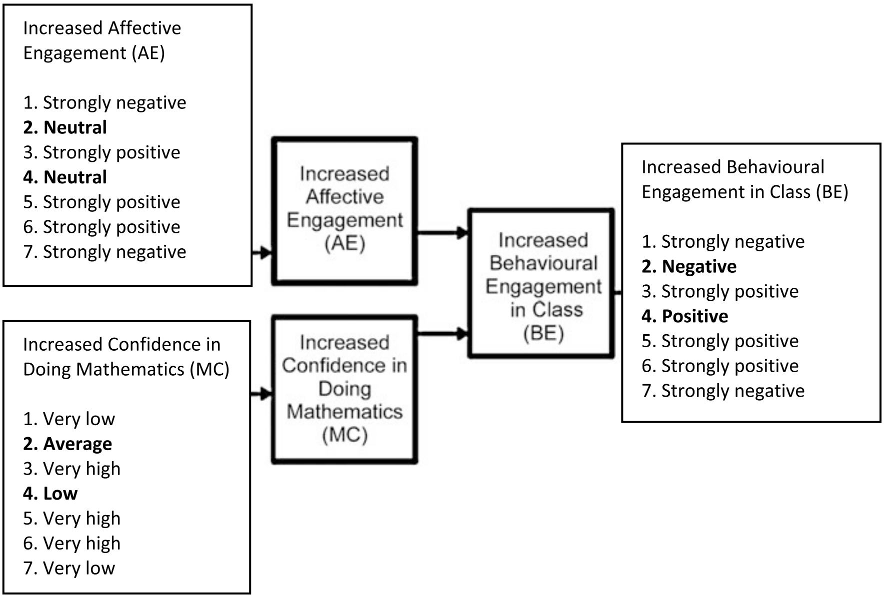

Fig. 1 Part of the hypothesised model on AE, MC and BE, together with the profiles of students in the seven clusters found in Study 2

as a gauge to provide feedback to the hypothesised model to test its applicability. Evidence from Study 3 supports the model, since the three factors AE, MC, and BE were associated with students' attitudes towards using technology to learn mathematics (MT). In Study 1, statistically significant gender differences were found for all subscales except BE from the students in co-educational schools. This suggests that gender could be a factor included in the model, or that perhaps the model might be different for males and females.

In Study 2, seven clusters of types of student characteristics were found among the 1068 secondary school students in Greece. In reading about the study, I assumed that these groups of Years 9 and 10 students had been using technology to learn mathematics, and that they had time to form attitudes about learning mathematics with technology, although it is not certain if teaching approaches such as using real world problems (the basis of the MTAS instrument design) were used. Part of the theoretical model predicts that increases in AE and MC lead to an increase in BE and improved learning outcomes, as shown in Fig. 1. In the corresponding boxes next to the subscales AE, MC and BE are found the characteristics of the students in the seven clusters (numbered 1 to 7), as were reported by Barkatsas. Most of the cluster characteristics seemed to fit the model, except two, clusters 2 and 4 (shown in bold in Fig. 1). Cluster 2 students had neutral AE and average MC, yet negative BE. They also had average achievement and low TC (not shown in Fig. 1). The gender composition of cluster 2 was roughly equal (45.7% males, 54.3% females), although statistically more likely to be female. Cluster 4 students had neutral AE and low MC, yet positive BE. They also had average TC, average achievement, and were statistically more likely to be female than male (36.2% males, 63.8% females).

In addition, cluster 6 students had scored highly on all subscales (AE, MC, BE, TC) except MT (strongly negative), had high mathematics achievement, and were more likely to be male than female (60.2% males, 39.9% females). This group of technologically and mathematically confident students (12.7% of the whole sample) with strongly negative attitudes towards using technology to learn mathematics seemed to contradict the model's prediction that "positive attitude to using technology to learn mathematics is seen as an outcome of improved learning" (Pierce et al. 2007, p. 287).

These discrepancies suggest that the relationships between the factors might need to be revised, and that gender and/or other factors might have a more direct impact on students' behavioural engagement and attitudes towards using technology to learn mathematics.

2 Theoretical Basis of SATS

Barkatsas used the Survey on Attitudes Towards Statistics (SATS), an instrument developed by Schau et al. (1995) to measure students' attitudes towards statistics in four dimensions: affect, cognitive competence, value, and difficulty. The four dimensions were generated empirically, through words and phrases produced by a panel of statistics students and instructors, and from reviews of existing instruments (Schau et al. 1995).

Although Schau et al. (1995) and others (e.g. Chiesi and Primi 2009; Hilton et al. 2004) found four factors using confirmatory factor analysis, there were others with different findings. For example, Cashin and Elmore (2005) compared student pre- and post-course data for three main instruments on attitudes towards statistics (Statistics Attitude Survey, SAS, by Roberts and Bilderback, in 1980; Attitudes Towards Statistics Scale, ATS, by Wise in 1985; and the SATS) and concluded that both ATS and SATS have two domains, contrary to the four-factor solution.

Barkatsas contributes to studies on using SATS, by investigating the construct validity and gender differences for tertiary students in Greece and Australia. Hence I look forward to the detailed findings of Barkatsas' future work (e.g., Bechrakis et al. in press) to see if there is further elucidation of the theoretical framework underpinning the instrument.

3 Implications for Equitable Policy and Practice

The range of applications of technology for learning statistics (Onwuegbuzie and Wilson 2003) as well as for learning mathematics is continuously increasing. An investigation of the attitudes towards ICT use and their relations to student achievement forms only a part of the picture; we should also question if existing teaching approaches, schooling practices, and policies about technology use, situated within a particular educational system and socio-cultural context, contribute to gender differences in students' attitudes towards learning mathematics and statistics with ICT. A contextual perspective could guard against what Gutiérrez and Dixon-Román (2011) termed as "gap gazing", in which systemic and socio-cultural issues perpetuating the gap (achievement gap or, in this instance, gender gap) might fall into a researcher's blind spot. They gave the example of the debate on whether to use calculators or computers in mathematics classes, a debate in which educators and researchers often assumed that "schooling can somehow control what students 'learn' about mathematics, as if they are not already using such technologies outside of mathematics class to make decisions or to educate themselves" (Gutiérrez and Dixon-Román 2011, p. 31). They suggested re-examining the role of mathematics in society (for example the impact of technology on the kinds of mathematics we use) and rethinking schooling practices to match or to further influence that role. Focusing on a broader view of mathematics (including statistics) and education in order to address equity issues is a challenging task. The longitudinal studies proposed by Barkatsas could be a start to a new way of perceiving how gender differences develop and change in relation to different socio-cultural contexts.

The overall argument presented by Barkatsas has a few minor gaps. At the classroom level, Barkatsas recommended some approaches to improve female students' attitude, confidence, and engagement with using ICT to learn mathematics, but did not provide corresponding suggestions for improving attitudes towards statistics. For statistics, I found that Onwuegbuzie and Wilson (2003) provided a comprehensive literature review on studies aimed at reducing students' statistics anxiety. Some strategies that were found to be useful were: use of humour, use of open book and untimed assessments, explicitly addressing anxiety, application of statistics to real-world situations, journal writing, and the interpersonal style of the instructor. Although not specifically targeted at females, these general strategies to reduce statistics anxiety seemed similar to those from a feminist perspective. In her discussion on feminist pedagogy in mathematics classrooms, Jacobs (2010) described some useful teaching approaches which are based on research: use real-world or classroom based experiences; engage learners in inquiry and reflect on their work; encourage alternate methods of solutions; value the finding of alternative methods more than solving similar problems in the same way; emphasise the generation of hypotheses rather than proving stated theorems; use cooperative rather than competitive or individual activities; and make extensive use of writing as a means of learning mathematics. These teaching approaches could be applicable to tackle equity issues in both ICT-enriched mathematics learning and statistics learning settings.

Barkatsas' studies on the attitudes of students are exciting because they add, through the validation and use of the two instruments, to the body of empirical knowledge about how male and female students learn mathematics and statistics in the current information and technological age. The link between the two sets of instruments in the chapter could be made stronger. Since there is an increasing use of ICT for statistics courses, it would be interesting if the two instruments could be used together for a group of statistics students in future studies.

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