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THE IMPACT OF PHYSICS ANXIETY ON PERSONAL AND COLLECTIVE AGENCY IN THE PHYSICS CLASSROOM

Students' attitudes towards physics have been well documented and it is commonly perceived that female students' attitudes towards physics are less positive than male students. This has been found in studies researching a range of factors including interest, identity, subject choice, self-beliefs and participation. Physics anxiety is a phenomenon that can be described as how students have negative emotional dispositions towards activities in physics lessons and physics lessons themselves beyond test anxiety. Using the construct of one of the antecedents of self-efficacy, i.e. physiological states/emotional arousal which relates to levels of anxiety, significant statistical differences were found between the anxiety levels of female students and their male peers in physics lessons. Observations of physics lessons and subsequent qualitative interviews with students confirmed that female students tended to minimise their participation in physics lessons due to concerns about obstructing the learning of others if they proffered incorrect answers in lessons or did not understand a concept. High attaining female students highlighted that physics was not a subject for them confirming widely held stereotype that physics is viewed as more of a male pursuit. This research was part of a wider study investigating ways of enhancing students' self-efficacy beliefs in physics through in class interventions that could also prevent feelings of alienation in the physics classroom.

Keywords: Physics, Self-Efficacy, Gender Issues

BACKGROUND

With relatively few students choosing physics compared to the other sciences for post compulsory education and the generally perceived unpopularity of physics as a subject or topic of interest in wider society, there is a need to discover the essence of students' relationship with physics in school. Female students' attitudes towards physics in school are typically less favourable than male students' attitudes. Mathematics anxiety is a term that describes how students hold negative affective states/expressions in anticipation of and during lesson activities in mathematics (Roth and Walshaw, 2015). Roth and Walshaw (ibid) used Vygotsky's socio-cultural framework to investigate maths anxiety in the classroom and highlighted how students' anxiety stems from a loss of agency within the context of the classroom due to the influences of the classroom environment and the relationships students have with their teacher and peers. Though less researched as a phenomenon, physics anxiety has been found to similarly impact on students' affective states in physics lessons and has been considered as significant as other factors such as students' self-efficacy (Sahin *et al*., 2015). Student anxiety in physics has been labelled as a 'stereotype threat' (Steele and Aronson, 1995), highlighting students' perceptions of physics being a difficult subject as well as a male dominated pursuit. Trujillo and Tanner (2014) suggest moving from a student deficit model that solely focuses on conceptual development to a dynamic model that takes into account affirmative affective influences in order to improve students' experiences of their learning environment that will also help to develop their conceptual understanding.

Bandura's (1986) Social Cognitive Theory (SCT) attempts to explain the influencing factors that underpin human agency and its role in people's ability to exercise control in their lives. He argued that human agency derives from a dynamic relationship between personal, behavioural and environmental determinants. Self-efficacy, a key personal determinant, is described as a person's situated belief that they can be successful in a specific pursuit. Bandura (1977, p. 3) defined self-efficacy as "*. . . beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments*", which, in academic settings, relates to students' beliefs in their capabilities to succeed in subject related tasks and activities. A comparative study of male and female participants with similar performative levels in an introductory physics course (Marshman

et al., 2018) reported that female students had lower self-efficacy than their male counterparts due to their experiences, and perceptions, of their course. The authors highlight structural and sociocultural biases as well as the impact of the physics class environment with raised anxiety levels leading to female students doubting their capabilities to be successful in physics.

Students' low self-efficacy beliefs can raise their anxiety levels whilst attempting challenging activities which can generate avoidance strategies (Britner and Pajares, 2006). Studies at high school level have shown gender differences in self-perceptions of capabilities in physics (Hazari *et al*., 2010). Hazari *et al.* (ibid) also identify student participation in physics lessons as a factor in enhancing students' self-perceptions, in part due to the sense of becoming an authoritative participant in class with greater confidence and empowerment, i.e. a greater sense of personal agency.

Collective agency is another factor of human agency in Bandura's SCT and, in a school context, is associated with the interrelated dynamics of the classroom and the wider structures of school and society. In a physics lesson, the collective agency of the class i.e. the teacher, support staff and students, is not simply the additive sum of personal agencies but an emergent group-level collective property (Bandura, 2001). Students' motivations and actions will be facilitated by the collective belief of the class that it is possible to understand physics concepts, be focussed in, and enjoy physics lessons. Bandura warns against a dualistic dichotomy between personal and collective agency. Humans are not abstract entities divorced from social systems. Individuals interpretation of socio-structural authorised rules, practices and sanctions allows for a dynamic interplay between an individual and their environment. However, individuals do not just react to their environment, they operate proactively and generatively to influence and shape social structures highlighting the reciprocal nature of intrapersonal and interpersonal domains. Thus, if students, in particular female students, perceive their self-efficacy and personal agency as low in a physics lesson, the overall collective agency of the class will be impacted upon and may result in an overall reduced sense of capability to succeed in physics in school. This study's aims were to investigate female students' anxiety levels and their behaviours in physics lessons demonstrating their personal agencies in the wider social context of the class as part of a wider study focussed on interventions to enhance students' self-efficacy beliefs in physics lessons.

METHOD

The methods used in this study involved a survey, lesson observations and qualitative interviews. 117 students (female 54, male 63) across five classes (aged 14-16 years old) of the same secondary school completed a self-efficacy survey during one of their physics lessons. The survey instrument used was derived from the Sources of Self-Efficacy in Science - Physics (SOSESC-P) survey (Fencl & Scheel, 2005). The survey contains 33 items in total with 9 items explicitly focussed on the Emotional Arousal antecedent of Self-Efficacy (Bandura, 1997). The students responded to each item using a 10-point Likert scale with responses from 1 (not at all like me) to 10 (very much like me). The average score of each item was calculated to provide a proxy self-efficacy score in physics in school out of 10, the higher the score the higher the level of self-efficacy. Statistical analysis of the survey results was conducted on the whole scale and the physiological states/emotional arousal to determine if any gender differences were significant. Subsequent observations of physics lessons were conducted to monitor student behaviours towards activities and engagement in class. Follow up individual semi-structured interviews were conducted with students of varying self-efficacy values (n=6, 3 female and 3 male) that allowed students to provide more detail about their cognitive and affective experiences in Physics lessons.

RESULTS

Independent t-test between male and female students resulted in significant statistical differences for 18 of the 33 items from the SOSESC-P survey including 7 of the 9 items associated the emotional arousal antecedent of self-efficacy highlighting the overall more negative affective dispositions of the female students in physics lessons compared to the male students. Lesson observations highlighted that generally, female students, though engaged in all activities involving individual and small group tasks and discussions, rarely voluntarily participated in whole class discussions unless called upon by the teacher. Conversely, boys, particularly those with higher self-efficacy scores engaged more willingly, particularly to answer the teachers' questions. Female students' reasons for not partaking in whole class segments of lessons included not wanting to obstruct their peers' learning and not wanting to get things wrong as they were worried about how this would be viewed by their peers. Female students expressed that they had high anxiety levels in school on the days that they had physics lessons and had thus developed coping mechanisms of low participation levels in class resulting in higher levels of self-motivated learning at home that could include researching for appropriate YouTube videos on various physics topics. The findings of the analysis of the survey date echo the findings of Sahin *et al*. (2015) in their evaluation of the Physica Anxiety Rating Scale where female students were found to have higher physics related anxiety than their male counterparts.

DISCUSSION AND CONCLUSION

Though their self-regulated skills appear to be nurtured, female students are missing out on opportunities to develop a relationship with their physics teacher by not receiving as much direct feedback about their progress compared to their male peers who are keen to interact with the teacher. It could be argued that this lack of participation by capable students renders transactional teaching into a more transmission-based lesson with students feeling anxious about participating and thus developing feelings of alienation with reduced opportunities to develop self-efficacy beliefs and interpersonal skills in physics lessons leading to an attitude that physics is not for them, thus confirming the stereotype threat. To support students having more positive perceptions of their capabilities and to develop more inclusive environments to enhance students' sense of personal and collective agency, there should be more consideration of students' affective states and the class cultural climate in physics teaching.

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