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RESEARCH ARTICLE

RESEARCH PROPOSAL: ENGAGING MORE GIRLS IN LEARNING PHYSICS

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ABSTRACT

Physics is generally less popular with girls than other sciences such as Biology and Chemistry. The subject appears to be perceived as difficult and not interesting to most girls. This situation is echoed by the low enrolment of girls taking Physics at the upper secondary level and further lessen the number of girls to continue their studies in the engineering/ technical fields. Eventually the Physics-related workforce consistently dominated by man. The aim of this study is to gauge the factors that potentially increase the interest of girls studying Physics. The study will be focusing at the girls' aptitude, their opinions on the Physics curriculum, motivational factors from the surroundings and their knowledge of the histories of Physics inventions. Purposive sampling will be employed to both girls and boys that is currently taking Physics at the upper secondary level and their respective Physics teachers. This study wishes to find the factors that will make girls see Physics as an exciting subject as seen by boys. The results will be used to encourage more girls engaged with Physics in future and reducing the gaps in the man's domination in the Physics-related careers.

INTRODUCTION

Physics is the beholder to all technology based on its nature on addressing phenomena involving the interaction of matter and energy. This interaction is applied to integrate all science concepts to produce technological needs for the ever changing society. Whether an individual is conscious or not, he/she requires a basic understanding of physics in handling home appliances such as the door knobs, house flooring, plumbing, watching television, sitting on chairs and even in every step of walking around. The basic knowledge involved are rotations, force, accelerations, angles, frictions, velocity, balance etc. Physics influences all applications in science and one of the most important fields is in medicine and the longevity lifespan of human race. Medical methods including imaging techniques (X-rays, CT-scanning, ultra-sound echo techniques, MRI techniques) and diagnostic patient screening techniques are based on physics principles. A wide variety of treatment techniques made possible by the discovery of radioactivity and other high frequency radiations. The discovery of the DNA structure in 1953 by Watson and Crick and the subsequent genome project required a significant input from physics techniques. Their discovery yielded ground-breaking insights into the genetic code and protein synthesis. During the 1970s and 1980s, it helped to produce new and powerful scientific techniques, specifically recombinant DNA research, genetic engineering, rapid gene sequencing, and monoclonal antibodies, techniques on which today's multi-billion dollar biotechnology industry is founded.

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The development of high precision machines and equipment in the industries also require the employment of physics principles (Musasia et al. 2012). The current fixation with information communication technologies (ICTs) could not have occurred without the primal physics discovery of the transistor. Computers, mobile phones and their attendant spin-off technologies show the indispensability of physics. Photonics and other quantum nanostructures show promise in terms of optical fiber based communication systems (Sharma et al, 2010). Laser applications are used in commerce and industry; and the electromagnetism is vital in the generation of electricity, mobile phone communication, optical and satellite communication, portable electronics, radio and radar perception, and X-ray crystallography (Campbell, 2006). However, physics education all around the globe has been undergoing a declination. Most of the reasons found are the weak mathematics foundation, unforeseen job opportunity, inadequate qualified / dedicated Physics teachers and the taboo of physics being too difficult, abstract and extensively theoretical. The subject is considered devoid of applications in the day to day life. Many students find the subject boring, unenjoyable (Hirschfeld, 2012). Interest in high school physics is decreasing, learning motivation is declining, and the examination results are getting worse (Garwin and Ramsier, 2003). In many school settings, little time is allotted for the discipline compared to language and mathematics, the other important subjects (UNESCO, 2010).

Literature Review: Mitrevski and Treagust (2011) mentioned that in recent years, the numbers of girls in secondary and tertiary education studying Physics have declined. Their findings show that in general these students do not relate well to Physics, there is some optimism and opportunity evident. Apart from a strong view that Physics is difficult, other responses show that students are unsure about Physics rather than expressing negative views. The implication for teachers is to show Physics as a human endeavour (Metrevski and Treagust 2011). According to Thomson (2011), girls are under-represented in physics post-16. They continue to make up only 22% of those taking A-level Physics, despite the many changes in the educational system over the last 20 years. Archer et al. (2017) claim that female underrepresentation in postcompulsory physics is an ongoing issue for science education research, policy, and practice. Their study focus in particular on seven girls who aspired to continue with physics post-16, discussing how the cultural arbitrary of physics requires these girls to be highly "exceptional," undertaking considerable identity work and deployment of capital in order to "possibilize" a physics identity--an endeavor in which some girls are better positioned to be successful than others.

Gill and Bell (2013) stated that there has been much concern recently in the UK about the decline in the number of students studying physics beyond age 16. They found that factors associated with greater probability of uptake included better attainment in physics (or combined science) and maths qualifications at age 16 in comparison to other subjects, and (for girls only) attending an independent or grammar school. While it is difficult to address these factors directly, the results imply that more needs to be done to improve relative performance at General Certificate of Secondary Education, perhaps by increasing the supply of specialist physics teachers at this level and to overcome the perception (especially among girls) that physics is a particularly difficult subject (Gill and Bell 2013). Murphy and Whitelegg (2006) discuss selected findings of a narrative review, in response to the continuing decline in the number of girls studying physics post-16 in England. 177 selected sources, of national and international research literature about girls' participation in physics, were reviewed. They argue that gender and science are mutually constitutive and girls' participation in physics education, historically and currently, needs to be understood in relation to this. Prior achievement and perceptions of the difficulty of physics are determinants of students' decisions about whether to continue to study physics.

These influences may be heightened for girls by gendered associations about who is, and is not, competent in mathematics and physics. Interest and enjoyment in physics also influence students' course choices, particularly those of girls, and these decline relative to other sciences through schooling, more so for girls than boys. This decline is not disrupted by school organization. Single-sex organization is associated with high teacher expectations in science and a greater sense of "belonging" for girls, but not for all girls. The contents, contexts and ways of approaching problems and investigations in physics more closely reflect what boys, more than girls, engage with outside school, and those activities associated with what culture defines as masculine rather than feminine attributes. These exert a negative influence on girls' engagement with physics, their sense of self-efficacy in relation to it, and their perception of its personal relevance. Girls, relative to boys, continue not to see a future self engaged in physics and physics-related careers. This can be disrupted by changes in the curriculum and in pedagogy. Context-based courses alter how physics content is organized, and impact positively on overall performance, and on girls' performance relative to that of boys. They also raise fundamental challenges to physics education and its perceived educational purpose. Developments in science education in England, they suggest, do not challenge the gender-science relationship and their impact on girls' participation may be limited as a consequence (Murphy and Whitelegg 2006). Mujtaba and Reiss (2013) investigates the characteristics of 15-year-old girls who express an intention to study physics post-16. A comparison between boys and girls indicates the pervasiveness of gender issues, with boys more likely to respond positively towards physics-specific constructs than girls. Their analysis also indicates that girls and boys who expressed intentions to participate in physics post-16 gave similar responses towards their physics teachers and physics lessons and had comparable physics extrinsic motivation. Girls (regardless of their intention to participate in physics) were less likely than boys to be encouraged to study physics post-16 by teachers, family and friends. Despite this, there were a subset of girls still intending to study physics post-16. The crucial differences between the girls who intended to study physics post-16 and those who did not is that girls who intend to study physics post-16 had higher physics extrinsic motivation, more positive perceptions of physics teachers and lessons, greater competitiveness and a tendency to be less extrovert. This strongly suggests that higher extrinsic motivation in physics could be the crucial underlying key that encourages a subset of girls (as well as boys) in wanting to pursue physics post-16 (Mujtaba and Reiss, 2013).

Dare and Roehrig (2016) examined the perceptions of 6th grade middle school students regarding physics and physics-related careers. They aim to understand similarities and differences between girls' and boys' perceptions surrounding physics and physics-related careers as part of a long-term effort to increase female interest and representation in this particular field of science. Their findings indicate very few differences between girls and boys, but show that boys are more interested in the physics-related career of engineering. While girls are just as interested in science class as their male counterparts, they highly value the social aspect that often accompanies hands-on group activities (Dare and Roehnig 2016). Jugovic (2017) explored the role of motivation, gender roles and stereotypes in the explanation of students' educational outcomes in a stereotypically male educational domain: physics. The research sample included 736 grammar school students from Zagreb, Croatia. The results showed that girls had a lower self-concept of ability and lower expectancies of success in physics compared to boys, in spite of their higher physics school grades. Hierarchical regression analyses showed that self-concept of physics ability was the strongest predictor of physics school grades, whereas the utility value of physics was the key predictor of educational intentions for both genders. Expectancy of success was one of the key predictors of girls' educational intentions, as well. Endorsement of a typically masculine gender role predicted girls' and boys' stronger intentions to choose a stereotypically male educational domain, whereas acceptance of the stereotype about the poorer talent of women in technical sciences occupations predicted girls' lower educational outcomes related to physics. The practical implication of the research is the need to create gender-sensitive intervention programs aimed at deconstructing the gender stereotypes and traditional gender roles that restrain students from choosing gender-non-stereotypical careers (Jugovic 2017). Due (2014) describes a study which explored the social interaction and the reproduction and challenge of gendered discourses in small group discussions in physics. The results of the study reveal how images of physics and of "skilled physics student" were constructed in the context of the interviews. These discourses were reconstructed in the students' discussions and their social interactions within groups. Traditional gendered positions were reconstructed, for example with boys positioned as more competent in physics than girls. These positions were however also resisted and challenged (Due 2014).

Abraham and Barker (2015) argue that although substantial gender differences in motivation, engagement and enrolment behaviour are frequently reported in the international physics education literature, the majority of studies focus on students who intend to choose physics for their future study. Girls' motivation, engagement and sustained enrolment plans in relation to physics were found equal to or higher than boys' at various time points through the course. These findings highlight the need to change the existing gender-biased stereotype that students perceive physics as a male domain and that subjective motivation, engagement and enrolment plans will always report higher measures for males (Abraham and Barker 2015). Reddy (2017) points out that learners' attitude to learning science plays a vitally important role with respect to career choices. His study were analysed in terms of the A (affection), B (behaviour) and C (cognition) model of attitudes. The results reflect positivity on many items of the questionnaire in the learning of science for all three components of attitude. On the issue of gender differentials, there appears to be no significant difference in attitude between Grade 7 boys and girls towards learning science from a South African perspective. In terms of subject preference, boys were more inclined to study physics and chemistry, while girls had a higher preference for biology and astronomy. However, the need for a dedicated laboratory to conduct experiments for the purposes of conceptual development was identified as a priority by the learners (Reddy 2017).

Gonzalez et al. (2017) discussed the recent research on achievement in science asserts that motivation, emotion, and metacognition are important driving forces for learning. They examine the relationships between two physics class emotions (hope and anxiety), their motivational predictors (instrumentality and self-efficacy), and their effects on metacognitive problem solving strategies (planning, monitoring, and evaluation) and performance. Their findings suggesting that instrumentality and self-efficacy negatively predicted anxiety, and enhanced hope, planning, monitoring, evaluation, and performance; metacognitive strategies and performance were negatively predicted by anxiety, and were positively predicted by hope; metacognitive strategies positively predicted performance. Furthermore, the hypothesized mediated relations were also statistically significant (Gonzalez et al.2017).

MATERIALS AND METHODS

This research will employ a quantitative survey with offline questionnaires. the constructs included in the questionnaire will be the students' aptitudes towards Physics, their opinions on the Physics curriculum, motivational factors from the surroundings and their knowledge of the histories of Physics inventions. This study targets 300 students (preferably 150 boys and 150 girls) as respondents and their respective Physics teachers. This study will employ descriptive statistics and inferential statistics. The data will be analyzed with SPSS software to find the factors that potentially increase the interest of girls studying Physics and to draw out recommendations based of the findings.

Policy Impact: The identification of the factors hindering girls from taking Physics at the upper secondary from this study will be used to propose recommendations to encourage more girls taking this subject in future. According to Global Gender Gap Report 2017 by the World Economic Forum (WEF), women, on average, tend to be underrepresented in the (Physics-related careers) Engineering, Manufacturing and Construction as well as Information, Communication and Technology fields. In Manufacturing women make up only 16%. Thus the WEF 2017 suggest a two-pronged approach for advancing progress towards closing economic gender gaps. First, at the level of foundational education, there is a need to re-balance degree specialization choices. Second, within the workplace, there is a need to avoid further exacerbating occupational imbalances through gender-biased hiring and workplace practices that lead to a low rate of female applicants and a high rate of exit among female talent in certain industries. The former is very much related to the purpose of this study and hopefully will contribute to minimizing the occupational gender gaps in the next generations.

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