Approaches and Initiatives for Encouraging Learners into STEM

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Abstract: With the increasing demand for STEM professionals, together with many of the current STEM professionals approaching or already gone over retiring age, there is a current shortfall which is now an urgent requirement to be addressed by Western countries as so much of activities and life in general is increasingly technology dependent. Actions that are currently being taken to address this shortfall in the UK by academic establishments, organisations and professional bodies are considered in this paper. Some of these include those actions that are directed at encouraging a better gender balance in the future as well as those involving actions to attract students to be aware of STEM from an early age to supporting women returning to the STEM profession. Parts of our research examines the learning and studying approaches adopted by some of the learners, their levels of attainment and attitude to learning to use technology and using technology to improve their learning. The paper reports on the developments and improvements from some of these initiatives and activities implemented. Some of these actions include details of competitions from primary to postgraduate students, women only training sessions, online support groups for STEM women, ranging from technical to career and social issues, and details of CAS (Computing At School) support for teachers, both face to face and online, currently with over 30,000 CAS participants. In conclusion the paper reflects on a roll out of some of these activities and potential impact on enhancing interest and uptake of STEM subjects by both the young and older learners and across diverse levels of education.

Keywords: Stem education, learning styles, women in computing, professional development, computing at school

Introduction

Globally there have been recent advances in science, technology, engineering and mathematics which has facilitated problem-solving and a clearer understanding of complex systems. This has prompted a call for the creation of appropriate infrastructure to meet the needs of modern times (Swaid, 2015). This is a recognised revolution across all areas of science, engineering and education which deserves to be sustained through the development and implementation of appropriate policies for citizens and workforce who have the knowledge and skills for delivery of services over a long term. It is the belief that the means to engage in this process should be available to everyone at all stages of formal and non-formal education (from primary, through secondary and lifelong), training and professional development (NSF, 2007; NSF, 2013). This must be extended to all individuals and communities at all levels and in all disciplines.

With the increasing demand for STEM (Science, Technology, Engineering and Mathematics) professionals, together with the fact that many of the current STEM professionals are approaching or already over retiring age, there is a current shortfall which presents now an urgent requirement to be addressed by Western countries, as so much of activities and life in general is increasingly technology dependent (Ross, 2016).
Two areas of major challenges have been identified, when it comes to educating STEM teachers. They include an apparent lack of ownership of process and continuity relationship between STEM tutors and students and the second one is the challenge of being overwhelmed in caring for students' educational complexities, needs and workflow.

Actions that are currently being taken to address this shortfall in the UK by academic establishments, organisations and professional bodies have been considered (Uhomoibhi and Ross , 2010, Uhomoibhi and Ross, 2013). Some of these actions have been considered as crucial in attracting students to STEM subjects and retaining practioners in the STEM profession.

Professional Engineering Bodies

There are various professional engineering bodies actively engaged in encouraging women to assist in addressing this urgent STEM shortfall. All of the STEM professional bodies in their Codes of Conduct or of Practice include requirements to promote, diversify and encourage the maintenance of records of gender balance within their society. They are also are very active in reaching out to students at schools, colleges and universities.

There are a range of activities organised by professional organisations whose membership comprise individuals from the education, business and public sectors with varying levels of professional experience. This experience is brought to bear on activities of the specialist groups and regional branches. Experience is an essential element in education and has been considered and an essential one as it carries with it a rich resource for learners (Brookfield et al., 1995; Merriam, 2001). Professional organisations is seen as a melting pot that allows seamless interaction across levels, within disciplines and across sectors for deep learning to take place.

The BCS, The Chartered Institute of IT, (BCS, 2019) has a very active BCSWomen's Specialist Group that aims to provide on-line technical and more general support, in addition to face-to-face meetings, and to provide speakers as a female role models for careers events at schools, colleges and universities. Free or low-cost courses are also arranged to introduce women to coding and to up-skill existing professional women, especially those that are on extended career breaks, of say five years.

Computing At Schools

The computing at schools (CAS) is one of the initiatives of BCS, The Chartered Institute for IT. Various initiatives have been tried, including separate classes for boys and girls for technical subjects to encourage students into the STEM areas. Other initiatives have been based around encouraging computing games for all ages that are not so confrontational and are thought to be of more interest to attracting girls.

A major change was introduced in many schools in the UK in 2014 with a new computing syllabus aimed at all stages from primary through to the end of secondary level of education at the age of sixteen. This introduced more problem-solving approaches. This CAS, Computing At School, (CAS, 2019) initiative was generated mainly by the BCS with the UK Government and support from the IT industry. To assist the teachers at all levels experienced “Master" teachers were trained to help other computing teachers in their geographic area. A considerable amount of free online support material has been generated, together with online support at regional physical meetings to assist the teachers. The decision to introduce this syllabus at all levels at the same date has created a constantly increasing need for preparation for the teachers at all levels to produce new or modified material each year.

Anyone can join the CAS network at no cost . There are currently over thirty thousand members, the majority of whom are teachers but with a reasonable proportion that are currently IT professionals. There are currently CAS hubs in many counties outside the UK, including in Sweden, Germany, South Korea, Thailand, Dubai, and Qatar. Interest in the CAS approach has been expressed also by countries including Japan, US, Poland, Hungary, Belgium, Switzerland, Slovenia, Denmark, Estonia, Israel and New Zealand.

Organisations’ Actions

Some organisations are very active in reaching out to students at schools, colleges and universities. Employees can be encouraged to volunteer as school governors, and others as technical expert “helpers” for the teachers, to assist with the students’ projects and running after school engineering clubs.

Some organisations, especially in the technical area, maintain a “graduate scheme”, where students work for the organisation usually for a couple of years and receive regular training and experience in several different areas of the organisation. These graduate schemes, like the apprenticeship and placement schemes, are extremely useful in helping students to gain a range of technical experience, and helping them to choose the area for their future professional career.

Survey Results

Almost every year a number of surveys are conducted concerning the numbers and roles of employees in the STEM area, identifying particularly the trends including those associated with the gender balance.

The Royal Academy of Engineering reports that “Women make up 51% of the working age population, they make up only 8% of professional engineers. 6% of professional engineers are black and minority ethnic (BME) but 29% primary school children are BME” (RAEng, 2018). Studies also show that “Companies in the UK are projected to need 1.82 million additional people with engineering skills from 2012 to 2022. This means that we need to DOUBLE the number of graduates and engineering related apprentices coming out of colleges and universities (RAEng, 2016). The latest statistics just published on women in technology have implications for actions by various bodies including the governments. The serious shortfall, to meet the UK Government's recognised requirements, and needs to be addressed, not only directly by actions aimed at teachers, students from primary school to university, and also supporting STEM professionals, especially if their career has a break of several years.

Securing steady and adequate supply of employable STEM graduates is essential to meeting the needs of international business. Studies found that that 39% of businesses in the UK need more people with STEM skills and have problems recruiting, and 53% anticipate problems within the next 5 years. This situation is believed to be similar across the world. (CBI, 2014). Securing a plentiful supply of future STEM graduates is vital to fill international business needs. A Confederation of British Industry survey in 20141, found The situation globally is similar, with many of the delegates participating in this discussion reporting a shortage of STEM graduates within their own countries.

Conclusion

The future dependence in the accuracy and quality of software is a critical requirement, whether considering business, environmental or safety critical systems. To ensure that there are sufficient well qualified professionals in the future, the authors feel that it is essential to increase considerably the number of engineers. To achieve this, the students, their parents and teachers need to become aware of the wide range of interesting and rewarding, both personally and financially, areas of employment in the fields of technology.

In the future, possibly more emphasis needs to be aimed at the wider public, particularly the parents, about the future opportunities. This could be achieved by raising, to the wider public as well as students, the profile of scientists such as Professor Brian Cox and to include dramas such as the television series "Howard's Way" which was based around designing and building small ships. Other routes need to be considered to generate interest in STEM to satisfy the need for future professionals.

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