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Interest and Recruitment in Science: A Reform, Gender and Experience Perspective

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Abstract

This paper reports on Swedish results from a worldwide research project concerned with the Interest and Recruitment in Science Education (the IRIS-International study) together with results from a longitudinal national study on girl's views on out of school experience in science and technology in upper secondary education. The studies are framed in the structural situation of the Swedish educational system. The results show that there are reform and policy effects to consider in the discussion of recruiting more students in STEM. Interest in the subject, earlier school experience, achievement and teacher feedback is found to be important for educational choice in STEM. Specifically girls point out societal relevance as important. In addition there are elements outside the school setting with importance for educational choice. Moreover, girls point out visits to a museum and watching films and boys popularized forms of science and computer games. All students consider TV and activities outside school as important for their educational choice in STEM. When trying to implement outside school experience with girls in a longitudinal study in upper secondary education the interplay with school subject teaching is identified as missing. The friction between subject teaching in schools and connections with the surrounding world is proposed as important for future studies.

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Keywords: interest; recruitment; STEM education; out of school experience

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1. Introduction

A problem with recruiting students in the Science, Technology, Engineering and Mathematics (STEM) educational domain has been documented for a long time. The European research project "Interest and Recruitment in Science" (IRIS) with the aim to establish an extensive empirical foundation in discussions about recruitment to STEM (Henriksen, 2012) was enlarged in 2010 to include countries all over the world and called "IRIS-International". This paper present result from three different studies with the aim to discuss the influence of gender, experience and reform effects on educational choices in STEM. One data set is statistical and concerned with educational choice in Sweden. The other present result from the Swedish national IRIS study and the third present results from a qualitative study focusing specifically on girl's views on out of school experience with consequences for educational choice in STEM.

Some of the worries with the lack of students choosing STEM education are due to the relationship between STEM and economic development (Osborne et al., 2003). Reid & Skryabina (2002) showed distribution data from Scotland of entries in higher grade STEM from the early 1960s. Similar data are reported from Germany (Haas, 2005). Both point out that there is no clear evidence showing a declining trend affecting industry with a continuous loss in STEM. During the second half of the 20th century, Haas (2005) argue it is justified to draw the conclusion that data indicate changes and cycles instead of a continuous decline of students choosing STEM education. Actually there have never been so many people educated within STEM as today. Hence, what is the character of the problem? One point in this paper is to use different data sets, to include reform effects in the discussion and to critically discuss a national situation before arguing for a loss in interest and a decline in recruitment.

Vetleseter Bøe (2012) showed that to a large extent, there are socio-cultural factors involved in educational choices. Differences in student interest due to content within STEM, cultural differences, gender issues, differences in school systems, progression and transition points are examples that should be treated in models. She points out that the way students experience school science has consequences for future educational choices and for many students interest in science and technology decline as they move through the educational system (see also Tolstrup Holmegaard, Møller Madsen & Ulriksen, 2014). It has also been shown that students' interest in science and technology is not connected with traditional school subjects. The interest is rather content specific and touch upon dimensions below the subject level (Jidesjö et al., 2009). Thus, there is a need to divide the subjects into different content areas and investigate variations below the subject level.

In addition Vetleseter Bøe (2012) gives an account of girls as having lower self confidence in science education. They associate further science studies with high personal costs and identify themselves to a lesser extent with STEM careers than boys do. This is important since studies show that being successful in earlier education with high achievements has an influence on further educational choice within STEM (Lyons & Quinn, 2010; Sjaastad, 2012). Hence, in the ambition to recruit more students to STEM, everything that can strengthen self-efficacy in early science and technology education is important (see also Jidesjö et al., 2009).

2. Materials and methods

The national Swedish statistical data on student's choices for upper secondary level and university degrees were compiled from official national statistics (Statistics Sweden) in 2013 The purpose with these data was to check for reform effects and to frame and anchor results to the structural situation of the Swedish educational system.

The national Swedish IRIS data were collected between 2010 and 2012. In total 2372 first year university STEM students answered a 5-point Likert scale questionnaire ranging from 1 (not important) to 5 (Very important). 65% were males and 35% females, where a majority of the students were born in the 1990s. The students study at 10 different universities, within a number of different programs and subject areas. Almost a third of the students have experience from previous university studies, and often at another university than their present.

The quest was uploaded and distributed in a program called "Quest Back", which made it possible to check for validity and inconsistencies. In present paper, the focus is on previous experience. To test if there is a significant difference between males and females a cross tabulation with χ^2-test was used. Significance level of 5% was used for all tests.

The qualitative data comes from a longitudinal study between 2011-2014 in upper secondary science and

technology education focusing on girls' views on STEM education and careers by having them involved in out of school experiences. Activities like visits on STEM workplaces and to meet female role models were at the heart of the project. 101 girls were involved from four different schools. The data were collected by the use of open question questionnaires and interviews.

3. Results

3.1 THE STRUCTURAL SITUATION IN SWEDEN

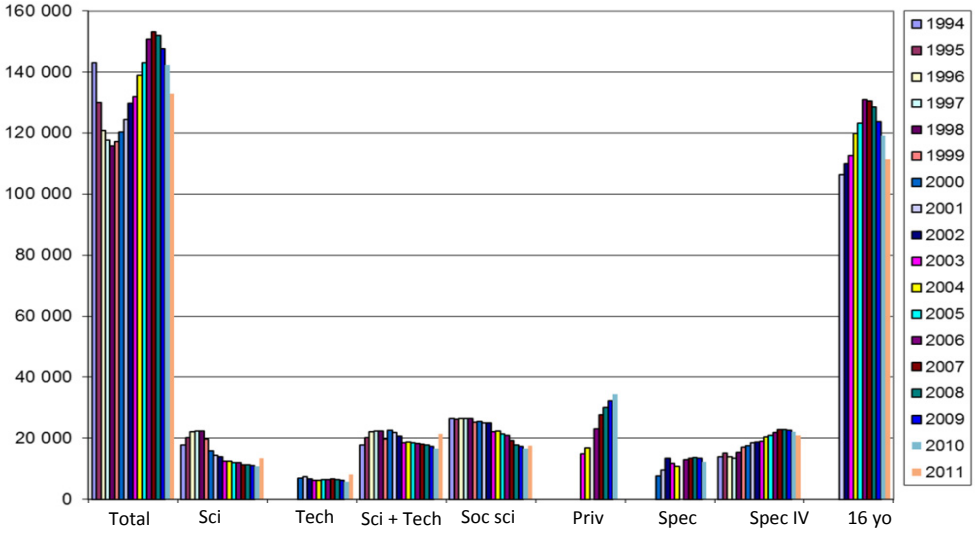

Fig. 1. Total number of pupils (Total) and 16 year olds (16 yo) in upper secondary education in Sweden between 1994 and 2011 within science (Sci), technology (Tech), social science (Soc sci), private schools (Priv) and special programs (Spec; Spec IV).

The result indicate a decline in science but the same trend is true for social science. At the same time private schools as well as special school programs increase their number of students during this period of time.

The result in Figure 2 show that the Swedish reform ambition in the 1990s to enlarge the university level in Sweden succeded. 15 years after this reform there are almost twice as many degrees. This increase is mainly due to social science. Almost nothing seem to have happened with the number of university students in STEM, in defiance of the reform ambition.

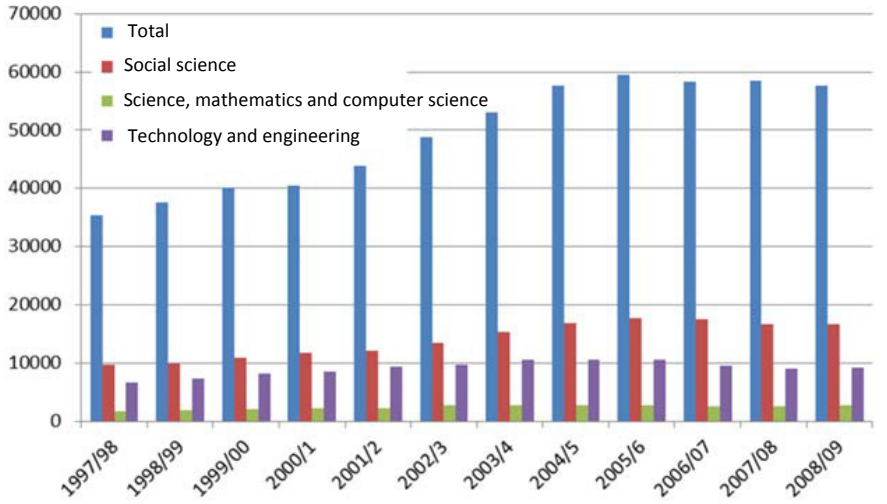

Fig. 2. Total number of university degrees in Sweden (Total) between 1997 and 2009 within Social science; Science, mathematics and computer science; and Technology and engineering.

3.2 STUDENT'S PREVIOUS EXPERIENCE IN STEM

The analysis of the Swedish international IRIS data show earlier experiences in science education, interest in the subject, feedback from the teacher and achievements as important for educational choices. For some of the variables: *Interest in the subject*, *Usage of subject* and *Usage of math* there was no significant gender difference (χ^2, $p>0.05$).

For other variables such as *Previous studies*, *Subjects relevant for society* and *Teacher's feedback* there was a significant difference between gender (χ^2, $p<0.001$). Females have a slightly higher ranking than the males. This means that females think that these factors have had a higher influence on their choice than the males do.

Experiments and laboratory work and *Field trips, excursions and study visits* were ranked by the students as less important. However, *Field trips, excursions and study visits* gave a significant difference between gender (χ^2, $p<0.001$), where the females ranked it higher.

In addition there are cultural elements outside school like popularized forms of science having an effect on student choices. These were ranked lower than previous experiences. There was no significant difference between gender when it came to *Importance of TV channels*, *Importance of competitions* and *Importance of other activities*.

For *Importance of popular science* and *Importance of Computer games*, the males gave a significantly higher ranking. Females, on the other hand, rank *Importance of museums* and *Importance of films*, significantly higher than the males.

3.3 LONGITUDINAL QUALITATIVE STUDY

The qualitative data coming from girls in upper secondary education indicate that connections with actors outside school working within the STEM have an influence on meaning making in school science and create a position where they can realize relevance of school work. Specifically teachers' competence to make use of such experiences and to include them in learning environments in school is identified as a critical aspect for further development of the project, since the result indicate that such qualities can have an effect on educational choice.

4. Discussion and conclusions

The national Swedish statistical data on educational choice from compulsory level to upper secondary together with university degrees revealed some reform effects. The national Swedish situation is not that there is a decline only in the area of science and technology. The social science programs show the same trend. And when looking at university degrees there is a steady state for the STEM programs. There are reform effects going on, important for making inferences which is in line with other findings (Reid & Skryabina, 2002; Haas, 2005). Could it be that what has happened in Sweden is an increase of private actors coming in and educating within the STEM area? We cannot be sure because their educational programs were not included in the official statistics but it is proposed as a possible reason to the structural situation. Probably, there is not a decline of recruitment in the STEM area caused by a disinterest specifically for science and technology. On the other hand there is no increase, which is being a national desire. What has happened recently in Sweden at university level is kind of a mass education in the social science areas. This situation could be further analyzed and critically discussed in relation to societal development.

Factors in the IRIS questionnaire ranked high by many students as important contributors to choose STEM education are earlier experience in school science, interest in the subject, feedback from the teacher and achievements. The result shows no gender difference in interest and subject usefulness. Those results are in line with international reporting (Vetleseter Bøe, 2012; Vetleseter Bøe et al., 2011; Lyons & Quinn, 2010). Interestingly, classroom activities such as inquiry based science and going outside school was not perceived as important for future educational choice. This does not mean that they are unimportant aspects of teaching. The point here is to show empirical evidence from students who have chosen STEM education at university level and their beliefs about what was important for their educational choice.

One desire in discussions about recruiting more students to STEM education is to increase the number of females (Vetleseter Bøe, 2012). In this aspect the result indicates that previous studies, societal relevance and teacher feedback is especially important together with out of school experience such as visiting a museum and watching films. Males were shown to be more in connection with popular science and computer games. All students ranked TV and activities like competitions as a reason for choosing STEM education. Those results indicate that in search for making recruitment in the STEM area more operational, changes in school settings are not the only contributor. There are important dimensions of out of school experience to consider, also pointed out by Sjaastad (2012).

The last result show that when giving girls, who have chosen STEM education for upper secondary level, a chance to put school instruction in relation with working life and societal relevance they were positive and said that those activities made them to understand why the things they learn in the classroom was important. Some respondents talk about this as important for their interest in the subject and for possible future educational choice in STEM. What seem to be lacking is to make those experiences part of continuing work in the classroom, i.e. as part of subject teaching. There is a potential in the structure created in the project, not being operationalized. The interplay between school and subject teaching and student's experience of the content outside school is suggested as important for future studies.

The results connect with messages from earlier reporting but adding some concrete messages. In discussions about recruitment in STEM, policy and reform effects have an effect on the structural situation of the educational system which is important to consider. Conclusions could be biased if the system is not understood. In Sweden the problem situation is not a decline in the STEM area caused by a specific disinterest in those subjects. But there is a wish to increase the number of students, specifically females. In making this desire more operational, the results presented in this paper indicate gender differences in experience connected with STEM, to be important to consider. Moreover, to make out of school experience more concrete, not as stand-alone, but as part of systematic daily school practice is proposed as another contributor and as an important task for future studies.

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