PUBLISHABLE SUMMARY

Interests & Recruitment In Science

Factors influencing recruitment, retention and gender equity in science, technology and mathematics higher education

IRIS context and main objectives

The need for a greater and more diverse STEM workforce

A competent workforce within the Science, Technology, Engineering and Mathematics (STEM) disciplines is essential in order to meet some of the great challenges the world faces in the first decades of the 21st century, for instance within renewable energy, communication, agricultural technology, medical treatments, transport etc. STEM is also identified as an important sector for economic growth and stability in individual countries and regions (EU, 2010). However, there is widespread concern that there will be a shortage of STEM-educated personnel in Europe and most Western countries, and in particular, there is a need for greater diversity, notably greater participation of women, in STEM (EU, 2004, 2008; OECD, 2008).

Improved participation in STEM is also a question of equity and empowerment. Access to STEM empowers individuals and provides opportunities for self development, career and democratic participation.

Improved participation in STEM entails a larger as well as a more diverse group of STEM students and professionals; it denotes a situation where society's needs for scientific and technological expertise are fulfilled and where each individual has a real opportunity to pursue a STEM education and career and participate in STEM-related decision-making.

Interests and Recruitment In Science (IRIS): Aims

Project IRIS, comprising six partner institutions in five European countries, was established in 2009 with support from the European Commission's "Science in Society" programme. IRIS aims to contribute to understanding and improving participation and gender equity in STEM higher education through addressing the following questions:

1. What are the priorities, values and experiences on which young people base their educational choice?
2. What are the success factors for interventions aimed at improving young people's participation in STEM higher education?
3. How do STEM students who opt out of a STEM study before graduation, explain their choice?

Theoretical frameworks

IRIS draws on different theoretical frameworks to address young people's educational choice processes and their relationship to STEM. A comprehensive framework is the expectancy-value model of achievement-related choices (Eccles & Wigfield, 2002). Another theoretical perspective informing the work in IRIS is sociological theories about youth in late modern societies, e.g. Ziehe and Stubenrauch (1993). IRIS also looks at young people's identity work and their construction of a narrative describing their choice, e.g. Smith & Sparkes (2008). Concerning students' decisions of whether or not to persist in their chosen STEM education, Tinto's (1993) model highlights the importance of social and academic integration. Finally, IRIS employs feminist perspectives (Haraway, 1991; Harding, 1986; Schiebinger, 1999) on women's participation in STEM.

Research methods

The questionnaire IRIS Q was completed by almost 7000 STEM students in the 5 IRIS consortium countries in 2010-2011. It comprised 65 items covering school science experiences, sources of inspiration for choice of education, expectations for future job, first experiences as a STEM student, and attitudes to gender equity in STEM. The target population was first-year students within 8 STEM disciplines defined through the ISCED Classification. IRIS also encompasses a range of qualitative and quantitative modules. These include for instance a combined questionnaire, focus group and interview study of the impact of school science curriculum on students' subject choices; a study of first-year female STEM students' written narratives ("life stories") of how they came to choose a STEM education, and an interview study of the narratives of first-year students as they negotiate whether to stay or leave STEM higher education programmes. Analyses of students' choice narratives are prominent in several of the qualitative modules.

IRIS main results

Choice as an ongoing process

Educational choice is not a purely rational decision taken at a particular point in time; it should be considered as a continuous process. Students' choice process continues after they have entered their chosen education when they try to balance their expectations with what they experience.

Interest, self realisation and identity

IRIS Q respondents strongly emphasise *intrinsic value* - interest, self-realisation, and passion for the subject - when describing their educational choice, at undergraduate as well as PhD choice level. Late-modern young people seek tasks which are stimulating and enriching, and which are perceived to correspond with 'who they really are'.

Concerning priorities for future career, respondents again highlight intrinsic value. Females favour idealistic priorities (helping others, protecting the environment) more than males.

The impact of school, teachers and mentors

School-related factors impact greatly on young people's choices, for instance their experiences of school science as more or less interesting and relevant, and the extent to which they identify with what they experience as school science identities. "Good teachers" were the persons rated highest as inspiring IRIS respondents' (particularly females') STEM choice. Females were also more inspired by lessons showing the relevance of the subjects for society. Teaching about socio-scientific issues within schools has generally had a positive effect on encouraging young people to choose post-compulsory STEM education. Mentors were important in Slovenian students' decision to enrol for a STEM PhD.

Out-of-school influences

Popular science and out-reach such as science centres, competitions and web sites were mentioned as inspirational by IRIS respondents, especially by males.

A study of three STEM recruitment initiatives found that successful projects were characterised by being developed and improved over time, providing a variety of experiences that may enhance students' interest and enjoyment and their expectation of success in STEM, that display STEM utility value and employment opportunities, that reduce participants' perception of cost through creating mastery experiences in a safe learning environment, and that enable young people to see themselves in STEM. The latter is related to personal meetings between participants and STEM tertiary students and/or professionals.

Staying in STEM, leaving STEM?

Analysis of register data in Denmark showed that the risk of leaving a programme was most strongly influenced by students' grades and parents' educational background. Only one third of the students leaving a STEM programme changed to another STEM programme, whereas very few non-STEM leavers changed to STEM. IRIS-Q data suggested that subject interest and whether students felt that the programme suited their identity, were the most important factors correlated with inclination to leave.

Analysis of the first-year experiences of students (both 'leavers' and 'stayers') showed that all students experience a gap between their expectations and what they experience. The gap relates to the form and content of the study as well as to job prospects. To cope with this gap, students need to renegotiate their educational choice narrative to make sense of the experiences.

Females in STEM

In Italian students' IRIS Q responses, a perception of science as masculine was evident and appeared to impact on educational choices. The experiences of women in a strongly gender-biased STEM programme in Denmark indicated that women still have to distance themselves from a female connoted practice and identity to become recognised as legitimate members of the STEM student community. Despite some gender differences on the group level as shown above, IRIS research has also displayed more diverse narratives about females choosing science.

IRIS recommendations and potential impact

IRIS aims to stimulate informed discussion concerning the participation of young people (notably women) in science, technology, engineering and mathematics (STEM). Results from IRIS have been – and will be – discussed in different fora. A book based on the IRIS consortium collaboration will be on the market in 2013, and the IRIS web site (http://iris.fp-7.org/) informs about the project.

The following guidelines and recommendations are aimed at stakeholders who are in a position to influence young people's educational decisions, either in the educational system, government, industry, or in professional societies. The guidelines are based on literature review and theoretical perspectives as well as results developed within IRIS.

Understanding educational choice and supporting STEM choice

1. Acknowledge that educational choice is an ongoing process over time
2. Acknowledge the crucial role of identity in educational choice: In order to choose a STEM education, a student must be able to see her/himself as a 'STEM person'.
3. Make parents, teachers and other persons in touch with young people aware of the important role they can play in young people's identity work and educational choice process
4. Present a range of different possibilities available in STEM careers to young people:
    a. Promote a closer involvement with industry to show applications and provide examples of careers
    b. Show STEM careers that allow helping other people, contributing to society and protecting the environment

Develop school science curricula that support informed participation in post-compulsory STEM

5. Develop recruitment initiatives across the full age range within schools
6. Provide a variety of school science experiences to match the differing interests of students within science
7. Include teaching/learning about socio-scientific issues within school science curricula

Support teachers in providing STEM instruction that creates and maintains interest for female and male students

8. Make teachers aware of how they can motivate girls and boys with different interests, strengthen students' self efficacy, and display the variety of applications and careers related to STEM
9. Help teachers to develop teaching approaches and work forms where girls and boys with a variety of learning styles are motivated and feel secure to participate and develop their understanding. For instance, collaborative work forms may be particularly important for many girls.

10. Teaching staff familiar with gender equity issues and STEM stereotypes can contribute to encouraging students in general, and females in particular, towards (PhD) STEM studies and careers.

Develop varied recruitment initiatives with opportunities for personal meetings

11. Develop recruitment initiatives that provide a *variety* of experiences: strengthening interest, building self efficacy, providing role models, and giving career examples
12. Provide arenas for personal meetings between secondary students and tertiary STEM students
13. Provide secondary students with information on the broad range of STEM professions available
14. Present STEM role models, especially female scientists
15. Allow recruitment initiatives to be developed and improved over time

Support undergraduate STEM students to enhance retention

16. Reducing the non-completion rate is particularly important for STEM programmes
17. Do not expect that students just fit into their new study programme
18. Address the sequence of courses within the study programme to secure first-year social and academic integration
19. Improve possibilities for student-staff interaction
20. First year is important, but retention initiatives should extend to second and third year

Address the views on STEM presented through media

21. Use the power of popular science and STEM-related fiction to provide examples of STEM identities and applications
22. Counter the stereotypic images of scientists that are still prevalent

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