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First-Year Students' Priorities and Choices in STEM Studies – IRIS Findings from Germany and Austria

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ABSTRACT: IRIS (Interests and Recruitment in Science; http://iris.fp-7.org/about-iris/) is a European 7th framework project focusing on the challenge that only few young people in general, and women in particular, choose an education and career in science and technology. Project IRIS aims to contribute to the improvement of recruitment, retention and gender equity patterns in higher education. To acquire information about the factors that influence the educational choice of young people, a questionnaire was developed by the IRIS consortium. The IRIS questionnaire is based on the model of achievement-related choices (Eccles, Barber, & Jozefowicz, 1999) and on the theory on the role of self-efficacy beliefs (Bandura, 1997). These theories provide a framework for investigating the central aspects that influence an individual's educational choice.

This paper reports the experience and findings of the IRIS survey conducted in Austria and Germany. The data are based on a questionnaire survey with 3680 first-year students. Additionally, interview data from Austrian biology students contribute qualitative data about supportive and hindering factors that influences the study choice. The findings indicate that experiences in the secondary school and good teachers are important in choosing a STEM study. To prevent drop-out key factors are relevance of the study choice for the own life, social and academic integration and supportive mentoring systems.

KEY WORDS: IRIS, women, gender equity, science, technology, career

THE EUROPEAN PROJECT IRIS

IRIS (Interests and Recruitment in Science; http://iris.fp-7.org/about-iris/) is a European 7th framework project focusing on the challenge that few young people in general, and women in particular, choose an education and career in science and technology. In order to develop strategies to recruit and retain students – women in particular – in STEM we need more information about the priorities, values and experiences underlying first year students' educational choices. IRIS aims to contribute to the improvement of recruitment, retention and gender equity patterns in higher education by answering following questions: On what priorities,

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values and experiences do young people base their educational choice? What are the success factors for recruiting more female students to STEM? Why do (some) students opt out of STEM education?

To acquire information about the factors that influence the educational choice of young people, a questionnaire was developed by the IRIS consortium. Associated partners in whole Europe were invited to take part in the comparative questionnaire survey. This study will report the experience and findings of the survey conducted in Austria and Germany. Additionally, interview data from Austrian biology students about their study choice and their specific situation as women in STEM studies contribute qualitative information.

THEORETICAL FRAMEWORK

The IRIS questionnaire is based on Eccles et al.'s model of achievement-related choices (Eccles et al., 1999) and on Bandura's theories on the role of self-efficacy beliefs (Bandura, 1997). These theories provide a framework for investigating the central aspects that influence an individual's educational choice. According to the expectancy-value theory, "*individuals' choice, persistence and performance can be explained by their beliefs about how well they will do on the activity and the extent to which they value the activity*" (Wigfield & Eccles, 2000: 68). The motivation of an educational choice consists of two main aspects: the student's expectation of success and the value the students hold in this particular option (Figure 1). It is assumed that students most likely choose courses that they think they can master while also having high value for them.

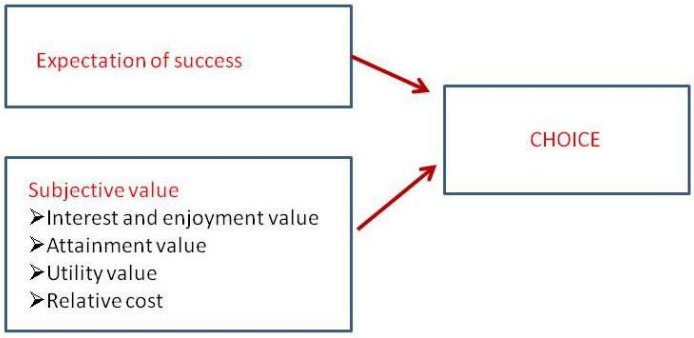

Figure 1. Expectancy-value model (Wigfield & Eccles, 2000)

According to the theoretical frame, the main research questions focus on two constructs directly influencing achievement-related choices: (1) the expectation of success and (2) the subjective task value. According to

Eccles at al. (1999), personal identity (student's self-concept) and social identity (how he or she sees himself or herself in social categories) have an influence on the expectation of success and the subject task values.

In addition, it is assumed that school experiences and the social surrounding have an influence for choosing a specific STEM course.

Based on the theoretical frame the research questions are:

1. How important are *school experiences* for choosing a specific STEM course?
2. How important are *third persons* for choosing a STEM course?
3. Are there differences between the female and male students regarding the *expectation of success* in STEM studies?
4. Are there differences between female and male students regarding the *subjective task values* (interest-enjoyment value, attainment value, utility value, relative cost)?

RESEARCH DESIGN

The IRIS questionnaire consists of 65 items covering school science experiences, inspiration for choice of education, expectations for future job, students' first-year experiences, and attitudes to gender equity in STEM. The majority of the questions are closed items. The categories of response are mainly five-point Likert scales, ranging from "Not important" to "Very important" or from "Strongly disagree" to "Strongly agree". A few items in IRIS Q are open-ended.

The IRIS Q was developed and validated by the international IRIS consortium according to educational standards (Bortz & Döring, 2003) under the guidance of the University of Oslo. The IRIS Q was offered to international partners in an electronic on-line version.

In Germany and Austria several national items regarding the country specific educational system were added to the IRIS Q before the questionnaire was translated in German and tested in two school classes in each country. In addition, the IRIS Q was communicative validated in interviews and by re-translation into English. The data were analyzed descriptive (means, standard derivation), significances were analyzed with t-tests. In addition factor analyses were conducted and the Cronbach's Alpha was measured (see section 4 Findings).

In total, 3680 science and technology students at the end of their first year of higher education completed the IRIS Q (Germany: N=2336; male: 58%, female: 42%; Austria: N=1344; male: 50%, female: 50%).

To gather qualitative data about students' choices, 18 biology students (9 diploma students and 9 teacher education students) at the beginning and at the end of their first year of higher education at Vienna University were asked for interviews (Mauk & Elster, 2011). Only female students were

interviewed because we want to gather authentic information about the specific situation of women in biology studies. We supposed that there were differences between the male dominated biology diploma courses and the female dominated biology education courses. The participation in the interviews was free and the selection of the interviewee randomly. The guideline-structured interviews were analyzed according to the paradigm of the Qualitative Content Analysis (Mayring, 2000).

FINDINGS

School experiences and study choice

How important were school experiences in choosing a specific STEM course?

The findings of the questionnaire survey indicate that mainly the interest in the subject influences the study choice (Figure 2). There are no significant differences between males and females, students from Austria or Germany. For female students the "clear feedback on whether you got the right answer" is significant more important than for males. For German students the "previous attainment in related subjects" is significant more important than for Austrian students.

Further school experiences that influence the study choice are "using mathematics in lessons", "lessons showing practical applications", "lessons showing the relevance of your subject to society", "field work and excursions". "Experiments and laboratories" are for male students more important than for female students (Figure 2).

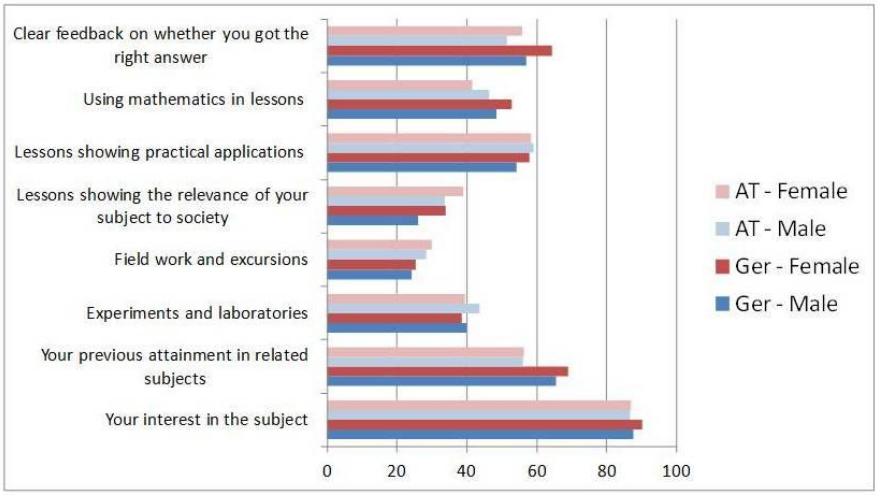

Figure 2. How important were school experiences in choosing a specific STEM course? 5-point Likert scale. N=3680. (% of agree and strong agree; AT = Austria; Ger = Germany)

Persons influencing the study choice

How important were third persons in choosing a STEM course?

Good teachers are the key persons who influence the choice of a STEM study. In Germany there are high significant differences between females and males according to this question ($M_{females}$: 3.45, SD: 0.73; M_{males}: 3.08; SD: 0.85p<.001). In both countries female students are more influenced by so-called important third (sister, brother, friend, father, mother) than male students (Figure 3) with statistical values between p<.001 and p<.05.

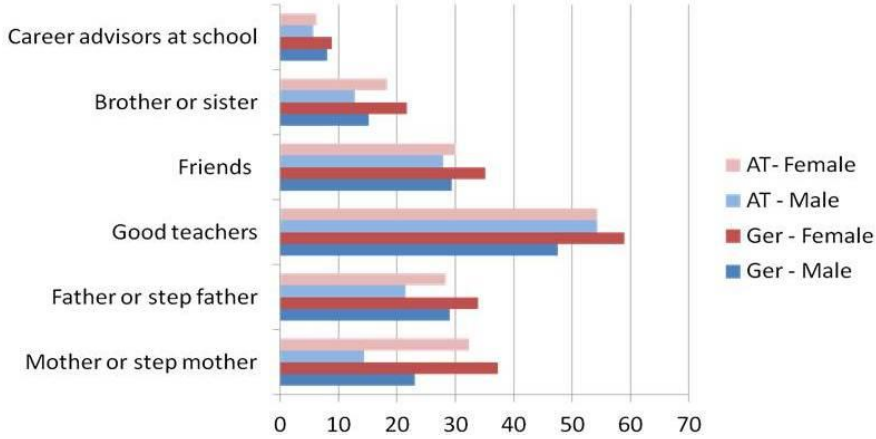

Figure 3. Importance of so-called important third. 5-point Likert scale. N=3680. (% of agree and strong agree; AT = Austria; Ger = Germany)

Expectation of success

The **expectation of success** of male students is significantly higher than that of female students (p<.01; 4 items; α=0.7; item example: "*I am confident that I am good enough at the subjects in this course.*"). These gender differences can be reported from the Austrian sample as well as from the German sample (questionnaire survey).

Subjective task value

The subjective task value is subdivided into four components:

a. The **interest-enjoyment value** covers the level of interest the young people have in the subject matter, and the extent to which one expects to enjoy studying the subject. It covers interest and intrinsic motivation (Ryan & Deci, 2000). Most of the students in Germany and Austria are very interested in studying their specific subject. However, 22% of the female students and 14% of the male students in Austria think about opting-out of their study program; in Germany these are 14% of the females and 12% of the males. The reasons for this include a lack of interest in the content of the course, the overall quality of teaching and the quantity of subject content.
b. The **attainment value** refers to how personally important it is to succeed with the education in question, and how well it fits with the individuals' identity. Most of the students in Germany and Austria are satisfied with their course choices. Male students feel more confident in succeeding with the educational course than females ($p<.05$; 3 items; $\alpha=0.78$).
c. **Utility value** regards how helpful a certain educational choice is in reaching one's personal goals. It is analog to extrinsic motivation (Ryan & Deci, 2000). Female students in Germany as well as in Austria are more extrinsically motivated or influenced to choose a certain course compared to their male colleagues ($p<.01$; 5 items; $\alpha=65$). For females it is more important to "*Get as secure job*" and to "*Start to make money as soon as possible*". For German students it is more important to earn a high income than for Austrian students. "*Working with something that is important for the society*" as well as "*Helping other people*" is especially important for females.
d. **Relative cost** refers to the negative aspects related to one educational option compared to another option. For German students the financial costs are more important when deciding to study a special course than for Austrian students. (German students: M: 2.83; SD: 0.85; Austrian students; M: 2.35; SD: 0.75; $p<.01$)

According to the findings of the interview study with 18 biology students the expectation of success of first-year students is mainly based on their school experiences: most of the biology students estimate their subject knowledge to be very high. They "feel confident for having chosen the "right" study for themselves." (Mauk & Elster, 2011). The expectation to be successful in concrete lectures (in near future) is not as high as the general expectation of success. The study contents are seen to be difficult, comprehensive and time intensive to learn. Every third student is not sure to be able to fulfil the requirements. But the interest on the subject level and enthusiasm and joy are high. "It is important for me to develop myself", "to work in an area of socio-scientific importance", "to do something that is of interest for me", "to work in the field of environmental education", "to utilize the own abilities", are factors that

influence the study choice in a positive way as well as "good job prospects" and the estimation "that the job of a biologist will be important in the future".

For biology students in Austria financial costs are not really relevant: "personal education is not the right place to save money". Comparative costs like "only little spare time" are seen to be typical for a biology study.

CONCLUSIONS

The findings of the questionnaire survey allow the identification of fostering and hindering factors for choice and stay in STEM studies. It shows that gender influences the choice and identifies some country specific differences. Summing up, the experiences in secondary school are important in choosing a STEM study. Key persons are good teachers. Key factor is the interest towards the subject.

The findings of the interview study support to understand biology student choices and help to identify supportive and hindering factors that influence the satisfaction with the study choice.

Our implications for supporting first-year students and preventing drop out are:

- Let students understand that STEM education is interesting and meaningful for their future life.
- Let students understand that STEM education will be a possibility to realize the own potential
- Strengthen self-efficacy; reduce the impact of perceived cost.
- Support students by their social and academic integration.
- Support mentoring systems esp. for female students

How these implications can put into practice will be objective of further research.

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