



Motives for Choosing an Area of Expertise in Chemistry: An Explorative Study at University Level

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Abstract

Studies have shown that, compared to other scientific and technical disciplines, gender research in chemistry is lacking systematic data collection concerning preferences of subject contents and methods [1, 2]. Only a study by Ramm (2008) has intensively researched the subject choices at university level [3]. It was shown that the decisions for studying a scientific subject were guided by different motives such as social backgrounds and the participation in advanced courses while still in school. Additionally, many students argue that their talents and professional interests were essential factors [3]. However, specific motives which affect the choice of an area of expertise while studying chemistry have not been identified yet, although they may represent a possible parameter for the optimization of offered courses at university level.

In this contribution, first scientifically sound results regarding the motives for choosing an area of expertise will be presented. Within an exploratory study, eight doctoral students (four female, four male) between the ages of 25-27 were interviewed retrospectively. It was shown that motives such as research interests, work environment during the thesis preparation, role models in the near social environment as well as the subjective level of difficulty are of paramount importance for a reasoned choice.

All the identified motives were correlated in a complex manner, showing their mutual influence in a trade-off between external and internal factors. Particularly the research interest, as an internal factor, plays an essential role, although there is evidence that it might be strongly influenced by external factors such as working environments. Furthermore, the motives were examined concerning gender-specific differences. It was shown that female doctoral students chose more formal formats (e.g. information events) during their decision-making process. Male doctoral students, however, rather follow role models. The description of correlations between these motives and the identification of gender-specific differences indicate a potential parameter for the optimization of science education at the university level and may ensure a gender-appropriate education.

1. Introduction

Studies over the past few years have shown that the interest for the STEM subjects in school as well as university education is rather low [1, 2]. This leads, according to the literature [4], to the current and future shortage of skilled professionals in corresponding professions. It is particularly noticeable that women in general tend to avoid the STEM disciplines, leading to a considerable gender-stereotyped segregation in the job market. Thus, extensive intervention measures were taken in the past to increase the participation rate of women and girls in the STEM disciplines. However, the corresponding measures did not show the desired effects and mostly fell short of expectations [4]. As Stöger et al. (2012) mention, the problematically low participation rates have, up to now, only been studied in certain areas (e.g. individual studies on women's and girls' self-concepts in STEM disciplines). In order to close these gaps, it is therefore desirable to include other factors into such studies, allowing a broader description of the causes of disparities in gender distribution.

The study by Ramm (2008) already identified that students are increasingly influenced by their professional interests and talents when it comes to the "choice of subject" (e.g. chemistry or physics). This study sets up new benchmarks for potential intervention measures on optimizing science education, since it also demonstrates that the problem must be considered not only globally, but also specifically for the corresponding STEM subjects. Albeit, Ramm solely compared the natural sciences per se in terms of the decision for a specific subject. The study, however, did not consider specific fields such as inorganic, organic and physical chemistry. A differentiation regarding the choice of an area of expertise within the subject chemistry has not been made and is not further described in recent literature (as of September 2016). It can be assumed, however, that within the different disciplines, various factors are influencing the level of participation and should be considered in a gender-specific light.

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We therefore conducted a study to retrospectively identify and describe motives of doctoral students in chemistry at the Georg-August-University Göttingen, influencing their choice for an area of expertise for their doctoral thesis, also considering their bachelor's and master's theses. Moreover, we were able to derive a number of gender-specific differences within the motives.

2. Situation description

At the University of Göttingen, chemistry is divided into three institutes: Inorganic Chemistry (IAC), Organic and Biomolecular Chemistry (IOBC) as well as Physical Chemistry (IPC). To obtain a more accurate description of the gender distribution within the individual sub-disciplines, data from the Faculty of Chemistry regarding the period of summer semester 2011 to winter semester 2014/15 were considered. By comparing the relative frequencies of the number of graduating women and men, a difference in the choice of institutes could be identified.

Figure 1 shows that female chemistry graduates increasingly choose the IOBC for the preparation of their theses. However, a declining trend from bachelor's to doctoral thesis was detected within the considered time frame. While the IAC shows a fluctuating trend, the IPC shows an increase in the women's quota. In case of male chemistry graduates, fluctuations can be observed in all sub-disciplines. As a general trend, however, it can be stated that the IOBC and IPC are preferred in contrast to the IAC.

The comparison between female and male chemistry graduates further shows that women prefer the IOBC, whereas a heterogeneous picture can be found in men. This leads to the question which motives may play a major role and how gender-stereotypic motives may affect the choice for an area of expertise.

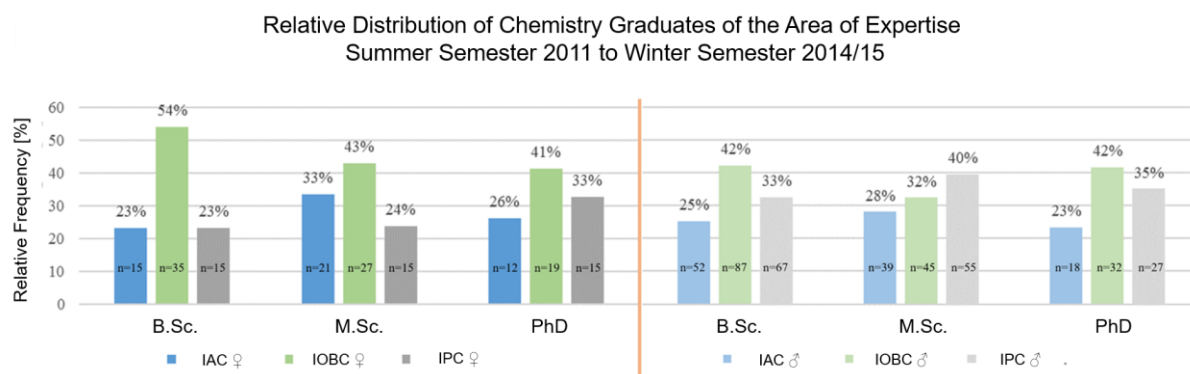


Figure 1: Relative distribution of chemistry graduates within the area of expertise. Left is the distribution of women, right the distribution of men.

3. Explorative Study

3.1 Sample

For the explorative study, a homogenous sample group was chosen [5]. The sample consisted of a total of eight doctoral students (four female, four male; age 25-27) from the doctoral program "Chemistry", as the survey was to be carried out retrospectively.

To ensure that all relevant motives at the university level were identified, the respondents were asked to make statements about their choice of an area of expertise regarding their qualification works and dissertation. It needs to be mentioned that the sample group did not correspond to the determined women's quota of the student body, since the women's rate in Göttingen averages between 21-41 % and is therefore not representative. The offset in the proportion of women was deliberately chosen, so that the identification of gender-specific motives could be worked out equivalently.

3.2 Methodology

Statements on the choice of an area of expertise were recorded retrospectively by using a semi-narrative guided interview at IAC, IOBC and IPC. Recorded interviews were partially transcribed and evaluated by applying a mixed form of inductive-deductive categorization. The development of the category system was performed after a summarizing qualitative content analysis. Resulting categories were used for establishing a coding guideline. By applying the coding guideline, the interviews were deductively re-evaluated to obtain a frequency of occurrence. Inductive and deductive data was combined to establish an individual weighting of each motive.



3.3 Results and Discussion

Initially, four main categories: study and teaching, personal motivation, social environment and economic motivation with associated subcategories were identified (see figure 2). Reevaluations of the results showed that motives in the main categories study and teaching, personal motivation and social environment were mentioned very frequently, indicating a high significance for the choice of an area of expertise. In contrast, economic motivations seem to have little or no influence on the decision-making process.

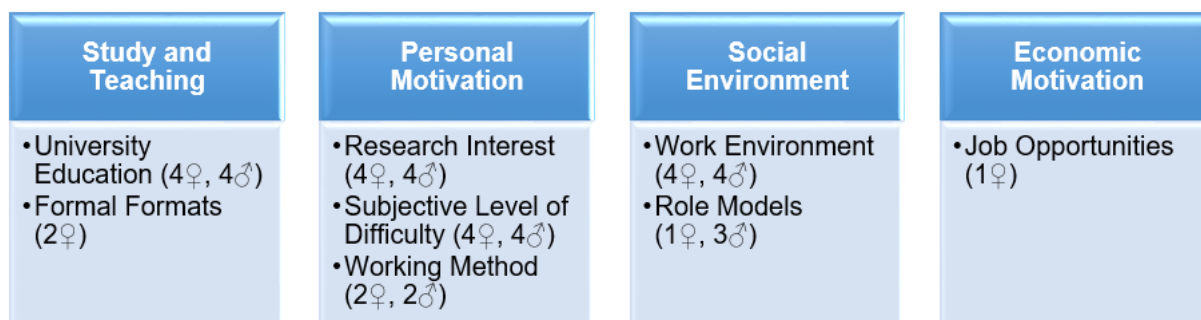


Figure 2: The charts show the main motives as well as their subcategories for the choice of an area of expertise. Numbers in the brackets indicate the gender-specific frequency of occurrence.

The systematic deduction showed that the sub-categories university education, research interest, subjective level of difficulty and the work environment are central motives in the choice of an area of expertise. Additionally, the working methods and role models were mentioned frequently. Furthermore, female respondents also mentioned formal formats (e.g. informational events, mentoring programs) as important orientation aids. The sub-category job opportunities played a minor role in the evaluated interviews, which is why it was not included in the further procedure.

Overall, it was possible to identify several interrelations between the sub-categories. It can be stated that university education is directly related to the research interest. Events such as lectures and practical training provide seemingly necessary impulses to arouse interest for a certain discipline. Furthermore, the research interest is usually reciprocal in relation to the work environment. It becomes clear that the interest in a specific discipline is neglected during specialization, if the work environment is perceived as positive. This phenomenon was particularly noted for the advanced phases during the academic career (master's program, PhD), since initial experiences regarding the work environment could first be made during the bachelor's thesis. In addition, it was shown that the research interest can be influenced by role models. For example, a role model in a social environment can be a strong driving force towards a specific research interest. Moreover, formal formats are important to gain insights into the working groups and their main focus. Only through careful consideration, the students were able to narrow down appropriate working groups offering research topics corresponding to their area of interest. A further connection can be established between the research interest and the subjective level of difficulty. A subjective level of difficulty can be perceived as a challenge and therefore must not necessarily induce an avoidance strategy if there is a strong research interest.

If regarded on a large scale it becomes clear that the research interest plays a central role in the choice of an area of expertise, which can, however, be associated with other factors and consequently also be influenced (see Figure 3). In order to identify potential parameters for intervention measures, external and internal factors were considered in correspondence to their weighting. With regard to gender-specific differences it can be discussed that female respondents placed particular emphasis on formal formats. In contrast to this, male respondents frequently mentioned that fellow students and PhD students in the social environment play an exemplary role in the decision-making process. A possible explanation for gender disparities in the IOBC, IAC and IPC can be derived from the interdisciplinary nature. Female respondents said that biological, pharmaceutical and medicinal topics are of particular interest to them. As far as chemistry is considered, especially the IOBC explores the above-mentioned topics in interdisciplinary contexts. The increased women's rate in the IOBC may possibly be explained by these circumstances as well.

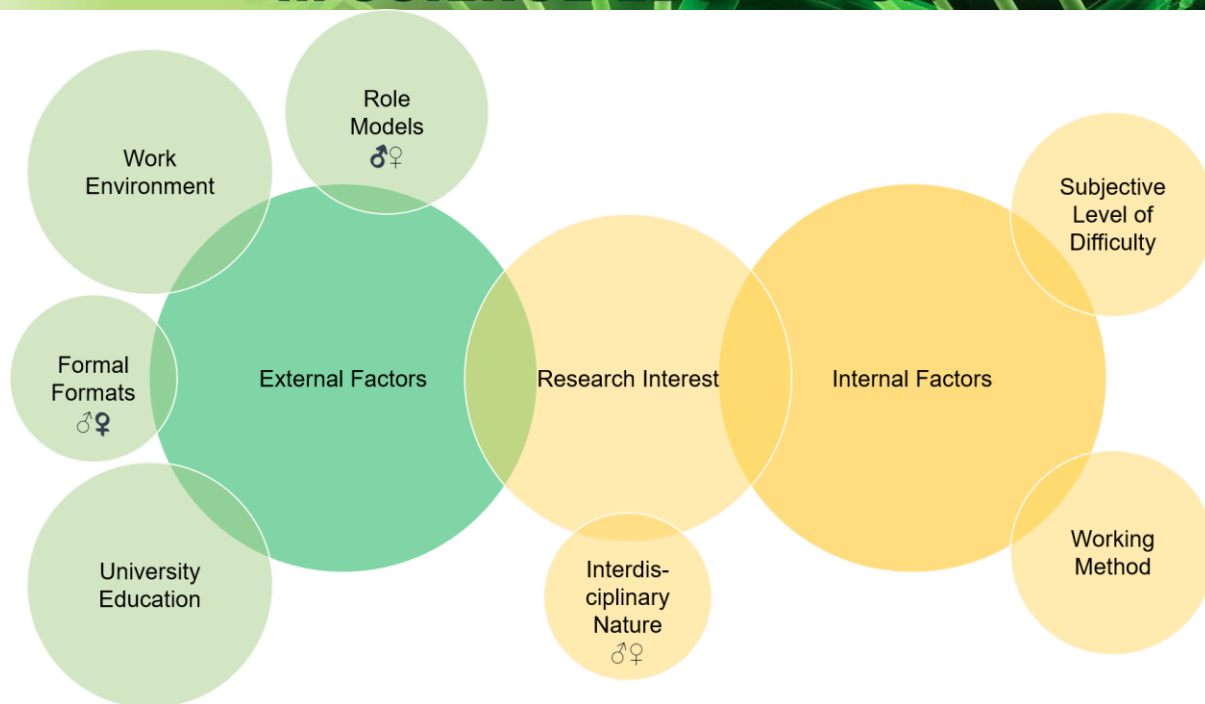


Figure 3: The complex construct with possible interrelations of the guiding themes for the choice of an area of expertise. The size of the circles demonstrates the possible weighting of the individual motives. ♂♀ stands for an anticipated gender difference. It is shown that the research interest as an internal factor can be strongly influenced by external factors.

When compared to literature the research interest has already been identified as a guiding theme for the subject choice at university level (e.g. chemistry, physics) [3]. Thus, additionally it can be said that the research interest plays a central role not only in the decision for a subject, but also in the choice of an area of expertise.

4. Summary and outlook

In the presented exploratory study, first indications for possible motives of the choice of an area of expertise were identified and interrelated. Furthermore, it was shown that female chemistry students from the University of Göttingen preferred the IOBC as a discipline for the preparation of their theses, whereas male students showed no conclusive preference. In addition to this gender-specific distinction, it was also possible to identify motives for the choice of an area of expertise which, moreover, can be discussed in a gender-specific context as well. In this respect the research interest in particular can be recognized as a central guiding aid, influenced by external as well as internal factors. Moreover, motives can be interrelated, which can be used to demonstrate that the choice of an area of expertise has to be understood as a complex construct. In order to evaluate and validate these findings further quantitative analyses with a larger cohort are going to be conducted soon. However, this in-depth analysis is intended to set the first milestone for the development of recommendations for a gender-sensible design of science education. Thus, chemistry as a subject in general as well as individual disciplines in particular can be made more interesting for the students of both genders.

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