Motives and career barriers choosing studies in Physics and Mathematics: gender aspects

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This article discusses the concepts of professional motivation and career barriers from the gender point of view. The research problem is expressed in the following questions: what personal and socio-cultural factors motivate young people to choose Physics and Mathematics study programmes? Are there significant differences in expression of motives and career barriers among male and female students? The sample consisted of 86 undergraduate students: 45 females and 41 male. Respondents were asked to write down their reflections as a free text answering the question why did they make such a professional choice choosing Physics and Mathematics studies. Motives that influenced the choice of Physics and Mathematics mostly expressed the dimension of *self-realization* and the dimension of *material achievements*. It was also found that both personality and social-cultural factors were important in choosing Physics and Mathematics, i.e. sensation of vocation and professional aptitude, as well as encouragement of relatives and good evaluation of future profession's status. There were also found differences in expression of motives and career barriers among male and female students

Keywords: professional motivation, career barriers, Physics and Mathematics studies, gender, Lithuania

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Currently the number of students, especially female, wishing to study Physics and other engineering subjects decreased. It is a big issue not only for Lithuania, but also for the entire European Union. Gendered fields of academic study still exist with men dominating science and engineering and women dominating arts and humanities (Smyth, 2005). A very small increase from 1999, when only 8% of top academic positions in science and engineering fields were held by women (CEC - *She Figures*, 2006; Collet, 2008). Engineering sciences still remains traditionally male professional field. Thus, females, who wish to study this particular field, need to overcome much more difficulties than men (Michie & Nelson, 2006).

A number of studies were performed in order to identify what factors and motives encourage young people to select one or other profession. However, just in few of them gender aspect is analysed, when traditionally 'female' or 'male' professions are to be selected (Young, 1984; Eccles, 1994; Hoel, 1995; Ozbilgin et al, 2004; Juuti et al., 2004; Creamer & Laughlin, 2005; Meszaros, Burger & Creamer, 2005; Darmody & Smyth, 2005; Kessels, 2005; Probert, 2005; Frome, Alfeld, Eccles, & Barber, 2006; Michie & Nelson, 2006; Murphy, Claude, & James, 2007; Urboniene, 2009; etc.).

Factors that influence the formation of professional motivation can function as stimulating or impeding it. Thus, young people while choosing a profession meet various internal and external obstacles that impede the development of their professional motivation. Those career barriers are especially important while trying to encourage girls and women to choose the field of Physics and Mathematics, which are traditionally male subjects.

Some researchers found that high school girls' career interests became increasingly traditional from freshman to senior year (Meinster, Rose, 2001). Other studies found that among college women who planned to be part of a dual career couple, those who expected to share roles with their spouses had higher self-esteem, higher levels of instrumentality, and higher commitment to a lifelong career than those who expected to have a conventional dual-career marriage (with traditional divisions of household labour) (Hallett & Gilbert, 1997). Frome et al. (2006) stress that girls and young women are not able to follow through with their plans because of the barriers (e.g., lack of affordable childcare, lack of schedule flexibility) that have always been there, despite the rhetoric.

Thus, this article aims to identify motivating factors as well as career barriers for male and female students choosing professional career in the fields of Physics and Mathematics in Lithuania.

Research questions: what personal and socio-cultural factors motivate young people to choose Physics and Mathematics studies and how is the structure of their professional motivation expressed? Are there significant differences in expression of motives and career barriers among male and female students? The *hypothesis* is that

female students experience more career barriers comparing with the male students while choosing to study Physics and Mathematics.

The following methods are employed in this article: the analysis of research literature, qualitative analysis and comparative analysis.

The article consists of the three parts. The first part begins with the presentation of the concept of professional motivation and career barriers from the gender viewpoint. The introduction of research methodology is examined in the second part. The analysis of the research results, revealing the differences in expression of professional motivation and career barriers among male and female students, is presented in the third part. After that the discussion follows where the main points of the research results are discussed.

Professional motivation and career barriers

Professional motivation is attempted to be defined as a system, uniting different needs of an individual, and is influenced by individual's relation with personal self and with socio-cultural environment. Three dimensions of motives for choosing a profession – *self-realisation, orientation towards a person and material attainments* – are theoretically grounded (Chung, 1977; Hoel, 1995; Urboniene, 2009). The factors that have impact on professional motivation are presented in Figure 1.
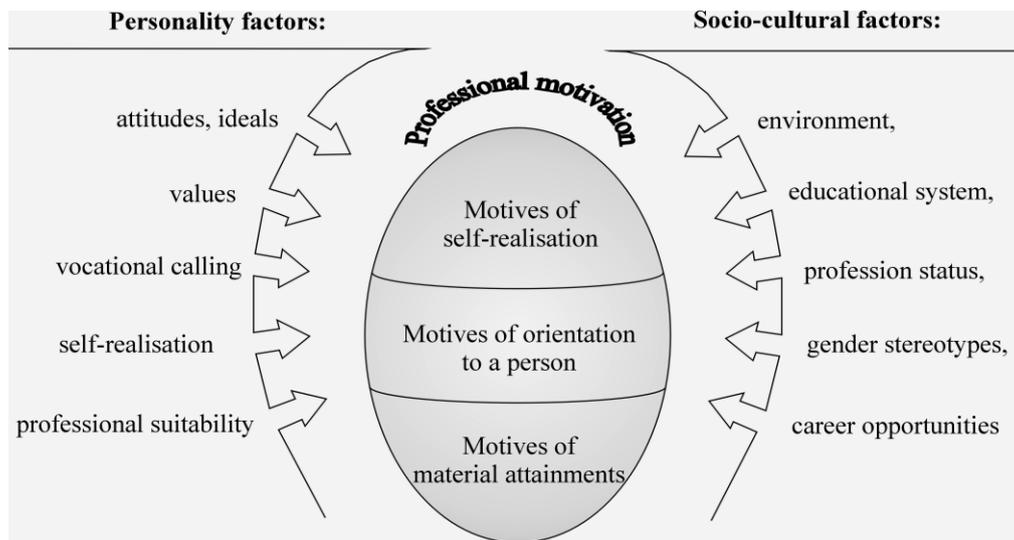

Figure 1. Interaction of factors influencing professional motivation

Formation of professional motivation is influenced by the dual factors as it is also seen from the model:

- *Socio-cultural factors,* including professional status in the society, organisation of educational system, gender stereotypes, social background;
- *Personality factors*, including professional calling, professional interest, professional suitability, values, experience, age and personal needs and motives.

Thus, socio-cultural factors play an important role on young people professional motivation and can function both stimulating and impeding. Professional *gender stereotypes* are important in this context because they cause the evaluations and choices of young people. It is stated that gender stereotypes are one of the main reasons that determines the horizontal and vertical segregation in the labour market and influence the gender roles as well as the choice of a profession (Purvaneckiene, 2008, 195). Even more, they also influence the evaluation of the own suitability for the profession.

Thus, masculinity, which is historically associated with rationality and physical strength, also express critical thinking, independence, self-confidence, aggression, objectivity, activity, materiality, ambitiousness (Wood, 2003; Alvesson & Billing, 1997; Urboniene, 2009). So masculinity in contrast to femininity still relates to expert management of technical knowledge (Connell, 2006), and this may impede women from choosing Physics or Mathematics as the professional field for the career.

The *status* within certain profession depends on such factors as wealth, power, status of clients, requirement of special skills, and non-routine work (Leicht & Fennell, 2001) and also is connected with gender stereotypes as well. For instance, it is stated that female students of science, Mathematics, and technology express significantly lower course confidence, receive less recognition and respect from lecturers comparing with the male students (Hughes, 2000, Augustiniene & Urboniene, 2008).

Not less influence on professional motivation and at the same time on choosing professional career is made by *educational factors*: efficiency of the education in schools, the role of the teacher, structure of studies, psycho-social climate, positive interaction between the teacher and the student etc. (Urboniene, 2009). The role of a teacher of the subject is of a great importance here. It is stated that teachers must be aware of how teaching might strengthen gender stereotypes because both genders must have equal opportunities to become familiar with Physics knowledge (Juuti et al, 2004).

It is also possible that women that have chosen to study traditionally male subjects as Physics and Mathematics may need more support from their *social environment*. And reverse from the others – family, relatives, and friends – they may meet more remonstrance and disagreement. In a study on the influence of factors

that determine students' decisions to study Physics in schools and colleges at a higher level showed that beside career aspirations as well as students' linking for Physics and good achievements, teachers' enthusiasm in teaching Physics is of a crucial importance (Hollins et al, 2006).

For instance, there were found significant differences by gender among students that have chosen engineering studies. While female students have drawn their influence from acquaintances and family of both genders, male students were mostly influenced by women from their environment. Another important finding was the influence of relatives on their choice of the profession, but this influence was stronger for the male students (Ozbilgin et al, 2004). However, it remains not clear if these influences were supportive or also negative.

Among personality factors evaluation of the own *suitability* for the profession is of a great importance because it is a result of the assessment of personal traits and features and their adequacy to qualities and necessary competencies, required for a chosen professional field. Positive experiences both in the family and at school related to the attractive profession may greatly stimulate the formation of the professional motivation. Also *values* and *personal motives* play an important role in this context. For example, Frome, et al. (2006) state, that the young women's desire for a family-flexible job, having aspired to a job with high time demands, and having a low intrinsic value for physical science led to failure to maintain a male-dominated occupational aspiration. Furthermore, young women who had male-dominated occupational aspirations in 12th grade, who had low desire for a job that would allow flexibility, and placed high intrinsic value on physical science were less likely to 'leak out'' of the math/physical science pipeline.

Further, the expression of *professional interests* and *attitudes* can reflect *vocational calling* that one feel for a special professional field. According to Lent, Brown & Hackett (1994, 2002), people's perceptions and interests are not simply expressions of personality but also appraisals of themselves and their environments. From this perspective, vocational calling can only become career interests to the extent that people believe they can perform the tasks required in a given profession and do not perceive any overwhelming barriers to their success. According to Simpson (2005), men choosing non-traditional occupations fall into three main categories: seekers (who actively chose the 'female' occupation), finders (who did not actively seek a non-traditional career but who found the occupation in the process of making general career decisions) and settlers (who actively chose the occupation, often as a result of dissatisfaction with a more 'masculine' job, and who then settled in their non-traditional career). Settlers, in particular, are associated with a more intrinsic career orientation and express a desire to remain close to occupational and professional practice. Role strain is prevalent in men's experiences in their non-traditional career.

Expression of the professional motivation is also connected with the concept of self-authorship, which is central to professional and career decision making (Baxter Magolda, 2002). The concept of self-authorship, a constructivist developmental framework, was first developed by Kegan (1994), proceeded with Baxter Magolda (1998, 2004) and discussed by Ignelzi (2005), Laughlin & Creamer (2007), Love & Guthrie (2005), Pizzolato (2003, 2007) etc.

According to Baxter Magolda (1998), self-authorship is the ability to reflect upon one's beliefs, also organize one's thoughts and feelings, and make up one's own mind. Integral to complex ways of making meaning, self-authorship is 'simultaneously the ability to construct knowledge in a contextual world, an ability to construct an internal identity separate from external influences, and an ability to engage in relationships without losing ones' identity' (Baxter Magolda, 1999). It is a complex phenomenon that involves three dimensions:

- *Cognitive* or what people believe and how they make meaning and judgments,
- *Interpersonal* or how people view the opinions of others in relationship to their own judgments, and
- *Intrapersonal* or identity as an internal sense of self-occupations.

Differently from Kegan (1994, 2005) Baxter Magolda (2004) recognizes four distinct phases of self-authorship: it begins with becoming the author of one's own life and moving toward internal foundation, which does not occur until after age 30. The first phase, *following external formulas*, refers to following formulas from the external world and lacking the ability to develop one's own voice. The second phase, *crossroads*, is instigated when there is dissatisfaction with following external formulas causing one to begin to consider one's own needs and perspective. The third phase *becoming the author of one's own life* results in deciding one's perspective and identity and how to manage relationships with others. The fourth phase, *internal formulas*, is defined as the management of external influences rather than being controlled by them. One develops interdependent relationships that take into consideration external circumstances and others' needs and also honours one's own internal foundation. Persons who were able to bring their internal voices to the foreground to coordinate external influence became self-authoring (Baxter Magolda, 2009).

According to Baxter Magolda (2001), the process of becoming self-authored involves intense self-reflection so that persons are able to articulate 'how I know' rather than 'how everyone else knows'. When the internal voice overtakes external influences, students are moving toward self-authorship. Persons are able to develop mutual, equal relationships with others, considering not only the other's needs but their own needs as well.

Analysing career decisions the concept of self-authorship is studied in various ways. For instance, it is applied to the way women described their critical incidents from the past that were connected with their career choice in a non-traditional field (Meszaros et al, 2005). It is also stated that not only educational experiences that promote self-authorship but also parents and others who play a significant role in the development of self-authorship in young women. Research demonstrates that self-authorship benefits all learners because they are able to manage complex intellectual, work, and personal challenges (Baxter Magolda, 2009). According to Baxter Magolda, 22-year longitudinal study of young adults' learning and development demonstrates that transformative learning required a shift from uncritical acceptance of external authority to critical analysis grounded in internal authority.

For instance, in one study findings from interviews with 40 college women also provide empirical confirmation for the link between self-authorship and career decision making (Creamer, Laughlin, 2005). Findings underscore the role of inter-connectivity in women's decision making, particularly involving parents,

and distinguish ways that this can reflect self-authorship. The results also endorse educational activities that require students to juggle competing knowledge claims to make complex decisions.

Self-authorship is also evident in the way participants described critical incidents during their lives that they later related to their decision to pursue a career in a science, technology, engineering, or math field. Many of these were related to early interest in and exposure to hands-on activities. Hands-on activities validate students as learners and knowers (Meszaros et al. 2005).

Further, choosing and pursuing a non-traditional career can cause various barriers that one perceives and that can function as a limiting factor in ones career choice. Analysing gender differences in career barriers' expression, some moments should be stressed.

Generalizing a number of the research cases made on career barriers Lee et al (2008) claims that career barriers have impact on many variables, for instance, on career decision, self efficacy, career indecision, vocational identity, optimism, career maturity etc. Among external and internal career barriers as the most significant those are stressed: lack of vocational information, lack of interest, future anxiety, interpersonal relationship, career indecisiveness, pressure from significant others, physical health barriers, financial and age-related barriers (Lee et al, 2008, 161).

In their study Quimby & O'Brien (2004) indicated that perceived career barriers accounted for variance in student and career decision-making self-efficacy for non-traditional college women. They have identified the following career barriers: multiple role conflicts, conflicts between children and career demands, lack of confidence, sex discrimination, and discouragement from choosing non-traditional careers, inadequate preparation, decision-making difficulties, and dissatisfaction with career. Many studies have indicated that low levels of self-efficacy often prevent females from considering occupations in math and science (Betz & Hackett, 2006; Hackett, 1985; Hackett, Betz & Doty, 1985).

In some studies on carrier barriers the attention on gender differences is directed. For instance, Smith (2004) states that women perceived significantly greater career barriers than men did, especially for career choice. The finding suggests that women believe they lack information about careers, expect greater career choice limitations, and are discouraged from pursuing careers in male professional fields, like technology.

Also Tien et al (2009) indicated that male and female students' perceptions were significantly different in three career barrier subscales: sex discrimination, inadequate experience, and discouraged non-traditional. It was identified that females perceive more career barriers than males in gender discrimination. Following, inadequate experience was another career barrier that showed significant gender differences. Interesting to notice that it was also found that boys perceived more career barriers than girls did in pursuing non-traditional careers. On the other hand, girls felt less discouraged in pursuing non-traditional career paths, such as mechanics and Physics. It was also stressed that encouragement or discouragement from parents or significant others may play an important role in young people career choice behaviour. At the same time stereotypes and negative societal perceptions may limit the selection of non-traditional careers.

Summarizing, factors influencing formation and development of the professional motivation may be bi-directional: as reflection of vocational calling and as reflection of support from social environment or as source of carrier barriers. Professional motivation is also connected with the concept of self-authorship, which expression demonstrates when, how and why gendered stereotypes of professions influence career decision. The process of listening to others' ideas about what kind of career might suit you, weighing it against a core sense of self, and then making a decision is reflected in a critical incident (Meszaros, Burger & Creamer, 2005). The development of self-authorship may explain why micro influences as inadequate experience are more significant in students' career choices than meso or macro influences. Significant gender differences found in career barrier (women perceived significantly greater career barriers than men in math, science, and technology, but boys perceived more career barriers than girls did in pursuing non-traditional careers) show the need of intervention strategies that build self-authorship and, therefore, self-confidence, as well as encouragement from parents to bring more person into non-traditional careers and retain them to high levels of success.

Methods

Participants

The sample was purposive: participants in this qualitative study were first year full-time students of Physics and Mathematics from two Lithuanian universities. The sample consisted of 86 undergraduate students: 45 females and 41 males. Respondents were recruited through verbal announcements. All respondents were volunteers.

Measures

While most studies have focused primarily on the statistical analysis of career barriers (Lee et al, 2008), we aimed to allow respondents identifying motives for choosing to study Physics and Mathematics and at the same time were looking also for the career barriers in they stories. Our research question was: What are the critical incidents that students identify as influencing their career choice? So respondents were asked to write down their reflections as a free text answering the question why did they make such a professional choice. The stories of the respondents were 1-2 pages long.

Data analysis

Qualitative analysis of content was based on the systematic step performance: 1) identifying the manifest categories, while referring to the 'key' words; 2) dividing the content of categories into subcategories; 3) identification of intersecting elements in the category/subcategory content; 4) interpreting the content data (Miles, Huberman, 1994). The comparative aspect allowed identification of differences in factors that made influence on career choices of male and female students.

Research ethics

The following principles of ethics were followed: responsibility of the researcher to inform respondents about the purpose of the study, voluntarism of the respondents involving in the research, and anonymity of the research.

Table 1. Structure of professional motivation

Dimensions	Female-students (with frequency indicated)	Male-students (with frequency indicated)
Self-realization	Development of thinking (8)	Development of thinking (5)
	A wish to distinguish among others (7)	A wish to distinguish among others (6)
	A wish to prove for environment (10)	A wish to prove for environment (1)
	Striving for knowledge (3)	Striving for knowledge (7)
	Practical application of knowledge (5)	Practical application of knowledge (5)
	Striving for self-realisation (3)	Striving for self-realisation (5)
	An interesting subject (5)	An interesting subject (3)
	A wish to try oneself (5)	A wish to try oneself (3)
	A wish to have power (2)	-
Material achievements	A wish to earn well (8)	A wish to earn well (5)
	Pursuit of independence (3)	Pursuit of independence (1)
	Pursuit for a diploma (3)	Pursuit for a diploma (1)
	Pursuit for recognition (2)	Pursuit for recognition (1)
Orientation to others	Benefit for others (2)	Benefit for others (1)
	Help for others (1)	-

Results

Structural elements of professional motivation

Considering the structure of professional motivation, which reflects the motives that influenced the choice of studies in Physics or Mathematics by female- and male-students, certain tendencies have been disclosed (see Table 1).

The tendency that self-realization dimension is the most important for the respondents from three dimensions of professional dimensions when choosing certain way for professional career has become evident. Some motives are common both for female students and male students, e.g. *striving for self-realization*. For example, one female-student states: *'I have chosen Physics because I decided that it was not worth to study what was not interesting; though later I would be paid well for this. I have also chosen Physics because I faced the chance to express myself'*. Male-students think alike: '*these studies can best disclose my personal abilities'*.

Development of thinking is also important for the respondents of both genders; they point out that *'exact sciences (Mathematics, Physics, etc.) develop my thinking, help to concentrate'* and, according to female-students, '*acquired better logic in any cases during the life'*.

The respondents of both genders who have chosen both Physics and Mathematics point out that they strived for *striving for knowledge*. For example, as one female-respondent states, *'here I will really be able to acquire new knowledge'*. The answers of the male-students are more detailed; it is evident that striving for knowledge for them is a bit more important motive than for the female-students who participated in the research. Examples of their statements are as follows: *'before entering the university I most of all wanted to understand the phenomena taking place in nature, their influence upon human being's life'. Thus I have chosen applied Physics for my studies'* or *'I wanted to know more in Mathematics, to enlarge my knowledge in this direction, I wanted to cognise the world from a mathematical side'*.

Some respondents chose Physics or Mathematics as *interesting subjects* because they wanted to relate their career to this science field: *'in my opinion, the science of materials is not only a dull title, which 'simple folk' do understand; this is the door to Very Interesting world'*.

Another important for female- and male-students is *practical application of knowledge* by noting use of general subject knowledge and application of specific knowledge for own benefit; for example, according to the female-students: *'this speciality involves the modules, which will be useful in life and work'* or *'I thought that I would learn how to behave with money'*.

A wish to try oneself is important for the respondents; they call their chosen studies as challenge for them or environment because the opinion that the wish to relate one's career to Physics or Mathematics is hardly implemented due to the complicated character of these sciences prevails. The male-students state that *'this is the hardest way because it requires maximum physical, mental and emotional resources, which are necessary for the future'* or *'I have chosen Mathematics because only here I can get what I need: challenges, trials, to identify the range of own possibilities'*. The female-students think alike: *'this choice is as challenge for me; I definitely have to overcome. I love challenges in my life'*.

It is interesting to note that some respondents (of both genders) have chosen the above-mentioned studies because of *their wish to distinguish among others*. As one female-student states *'I wanted to be exceptional because nobody from my school had chosen this speciality'*, and another female-student notices that *'when the surrounding people ask me what I study, I often surprise them; and this encourages me to follow my chosen career way'*. The male-students also define this motive of profession's choice alike: *'I wanted to be original and to distinguish from my contemporaries, who had chosen popular professions'* or *'I heard that students of the Faculty of Fundamental Sciences are considered to be eagles of the elite faculty and that after their studies they are respected because not everyone possesses brains and courage to study this complicated speciality'*.

Only female respondents expressed the choice of certain profession also as the implementation of the *wish to have power* by stating that '*it seems to me that Mathematics rules the world, and I want to rule it'*; *'I want to be important in making relevant decisions, and I think that, if I get a responsible job, I will be such'*.

It is worth to mention that though *wish to prove for environment* as motive of profession choice manifests the statements of both the female-students and male-students; however it is more important for the female-students because it was mentioned by almost one fourth of the female respondents who participated in the research. The expression of this motive differs in the aspect of genders as well: two things are important for the female-students: the

first – their wish to destroy stereotyped attitudes that exact sciences, first of all, suit men, as well as, secondly, the wish to prove others (especially the teachers of Mathematics who did not encourage them) that they are able to study the chosen complicated field of their studies:

'I settled the aim to learn Physics. One of the arguments why I got interested in such 'masculine' (as they used to say) science was that I always wanted to prove that men are not nearly more clever than women. I wanted to demolish such stereotypes…';

'…I wanted to prove that blondes can also be clever; and, in reality, many people get astonished when you say where you study; so I think that I have attained my aim';

'When I was little, I wanted to be a teacher of Mathematics; thus I wanted to prove my teacher of Mathematics who did not like me that I also could be a good mathematician';

'My teacher of Mathematics used to say that it was real terror to study Mathematics at university and only some people could choose such sciences. Thus I wanted to prove that it was not as complicated as she thought'.

Unlike the female-students, the male-students do not mention the vein of surrounding people against them for the chosen traditionally 'masculine' study field. However one respondent expressed his professional choice also as the wish to prove his abilities for the teacher of Mathematics who disclaimed him: *'We got a strict teacher of Mathematics, who debased out ability to master mathematical knowledge. The abilities were assessed unfair. The minute I have seen her I wanted to prove her that I was not as bum as she thought me to be'.*

It is evident that namely these statements of the respondents have revealed the barriers of their career the most important for them; the barriers are related to the negative influence of the people important for the respondents – subject teachers, relatives and friends.

The motives belonging to the *dimension of material achievements*, among which *the wish to earn well* distinguishes by its importance, are relevant for the respondents. The respondents of both genders point out that they want to get well-paid work, which namely is guaranteed by their chosen speciality, for example, *I won't hide that I am tempted by rather big salary of the work of these specialists'* (the statement of one female-respondent).

Several respondents mention *the strive for a higher education diploma* alongside other motives that determined their professional choice, for example, *'a modern educated person is hardly imagined without higher education'* (the statement of a male-student) or *'as no family member does not possess a higher education diploma and as I am the first child in the family, I give my parents great joy and pride'* (the statement of a female-student).

One more motive that reflects material achievements is *striving for independence* as the wish not to be dependent from their parents. Thus, according to one female-respondent, *'I have chosen studies in Kaunas so that I could learn some independence by living without my parents'.*

Some respondents also mentioned *striving for recognition* by pointing out that *his is a speciality where you can not only learn but also to create, and even to win distinction in the world'* (the statement of a female-student) or *'I would like that other people would recognize my capabilities'* (the statement of a male-student).

It is evident that motivational *dimension of orientation to others* is not relevant for the respondents who have chosen specialities of exact sciences. Only some respondents of both genders mentioned that when entering the university they strove for *benefit for others* as well: *I believed that I could create something useful for the mankind'* (the statement of a female-student) or *'I think that having studied secrets of the nature I could apply them for mankind and own benefit'* (the statement of a male-student).

One more female-student mentioned *support for others* as one of the motives from own professional choice: *'I have chosen that I could help, to teach others who face difficulties in this field'.*

Thus, as it became evident, the motives that guarantee good possibilities to express oneself and to develop in favourite knowledge field are important for the respondents who have chosen Physics and Mathematics for their studies, i.e. *the wish to enrich own knowledge as well as to develop own thinking, to implement oneself and to distinguish from others; as well as the wish to try oneself and to prove for the environment. The motives oriented to material achievements, especially the wish to earn well are also important because the respondents relate hard and exceptional studies to the latter. In summarising differences between the female- and male-students, it is possible to state that the motive of the wish to prove for the environment is more important for the female-students; they relate it to the prevailing stereotypes of genders and the profession.*

Influence of social, cultural and personality factors upon professional motivation

When analysing external social, cultural and personality factors that induced the formation of the respondents' professional motivation, it has been observed that several *socio-cultural factors*, influence of surrounding people, status of a profession and career possibilities, are important for the female- and male-students (see Table 2).

When speaking about the *influence of surrounding people* upon the formation of professional motivation, the influence of parents, a brother / a sister and other acquaintances should be distinguished. The respondents of both genders point out the *impact of teachers*, especially of a teacher of the subject chosen for their studies, upon their career decision. It is noted that this influence for the female-students has manifested even three times more often, and they point out two issues:

1) Encouragement of a teacher of a favourite subject to relate own life to the subject taught by him / her;
2) A teacher of a favourite subject – a remarkable pedagogue, who impressed by his / her good teaching and personality.

The following statements of the female students represent the encouragement of a teacher of their favourite subject to relate their life to the subject taught by him / her: *'My teacher of Mathematics, who had noticed my aptitude for Mathematics, influenced my decision; she encouraged, helped me and laid her hopes on me';* *'My teachers had noticed and estimated my abilities, thus they encouraged me to choose the field of Mathematics'.*

When speaking about *parents' influence* upon their professional choice, the respondents point out their parents' acceptance and encouragement as well as the similar way of their parents' career. For example, one male-respondent states that *'his parents made influence upon his choice because they liked possibilities of Mathematics career',* and one female-student emphasized inherited features as well: *'I have inherited my aptitude to exact sciences from my father'.*

Table 2. Socio-cultural and personal factors that influenced formation of professional motivation

Groups of factors	Female-students (with frequency indicated)	Male-students (with frequency indicated)
Socio-cultural factors	Perspective of a profession (17)	Perspective of a profession (11)
	Teacher's influence (15)	Teacher's influence (6)
	Good possibilities for career (8)	Good possibilities for career (10)
	Influence of surrounding people (6)	Influence of surrounding people (11)
	Father's / mother's influence (5)	Father's / mother's influence (5)
	Good possibilities for further studies (3)	Good possibilities for further studies (3)
	Brother's / sister's influence (5)	-
	Lack of specialists (4)	Lack of specialists (1)
	Free of charge studies (1)	Free of charge studies (3)
	-	Open-door days (1)
	-	Influence of student representation (1)
Personality factors	Aptitude (25)	Aptitude (18)
	Good results at school (8)	Good results at school (12)
	Logical thinking (1)	Logical thinking (3)

Only the female-students who participated in the research mentioned *brother's / sister's influence* upon the formation of their professional motivation: *'I have a brother; he is one year younger than I thus we have grown up together. He was interested in electronics thus he used to tell me about it'; 'my decision to study has been influenced by a younger sister because I want to be an example for her'.*

The male- and female-students mention *influence of acquaintances and friends* in choosing their profession a bit more often: *'relatives and acquaintances have indicated this learning field as giving many possibilities'* or *'several friends, who have already acquired this speciality and work at the bank or in programme design'.*

The status of Physics and Mathematics professions as well as possibilities for career is important for the respondents. When defining the status of their future profession, the respondents emphasized its *perspective*: *'when you finish Mathematics, you face great perspectives (from a programmer to an economist); you only have to know how to use them'* (the statement of a male-student) and *'this is a perspective branch, it is a great possibility to achieve something in own life and to be a valuable specialist in the future'* (the statement of a female-student). Due to hardly managed this knowledge field *the lack of specialists* increase the status of a chosen profession; thus, according to one female-student, *'I have chosen Mathematics because not everyone is able to study it and mathematicians are not many in number'.*

Good possibilities for career are an important factor that stimulated the choice of a desired profession because, according to one female-student, *'the speciality opens diverse possibilities for career in any field'.* The male-students think alike, for example, *'I was best attracted by career possibilities because after having acquired this speciality it is possible to work at a bank, where I have always wanted to work. I also chose Mathematics because I knew that I would be able to perform the work related to finance'.*

The influence of education system is not so important for the respondents as other the above-mentioned socio-cultural factors; however some respondents mention *good possibilities for further studies: 'there is a possibility to continue studies in the field of business, finance or economics, i.e. I would related my future work with this'* (the statement of a male-student) or *'having finished these studies, a master-student can choose from more fields, it is possible to go to economics, business, finance, etc.'* (the statement of a female-student).

Several respondents also mentioned *the possibility to study at the state funded place*: *'I had a possibility to enter a state funded place'* (the statement of a male-student). One respondent mentioned *the influence of students' representation ('student representation told about this study programme so nicely, thus I have chosen it without any doubt').* Also one male-student pointed out that the *open-door days* that took place at the university influenced his decision for his professional career: *'my choice was influenced by the open-door days that took place at Kaunas University of Technology'.*

When speaking about *personality factors*, which influenced the formation of the respondents' professional motivation, *aptitude* for exact sciences that reflects vocation and professional suitability of young people takes an exceptional place. Almost half of the female-students who participated in the research and a bit less than half of the male-students pointed out that they felt attraction for Physics and Mathematics from their childhood. For example, some female-students stated that *'from my childhood I was interested in numbers and calculation; I love numbers and want to spend my life with them'* or *already at school I liked numbers; when went to gymnasium, I understood that Mathematics was my vocation'.*

The male-students state alike: *'exact sciences and nature study attract. Laws of Physics stand in the entire environment; thus, when discovering and knowing them, it is possible to understand real environment and bound phenomena'* or '*I have chosen this way because from my childhood I was interested in a structure of a thing and how it functioned. I wanted to find out all secrets of the nature'.*

Good results at school, which were mentioned by the respondents, witness their suitability and vocation for exact sciences because, as one male-student points out, *'this field was the most successful for me (I went to the international Olympiad of Physics and won a bronze medal)'.* The female-students thought alike, for example, *'I took part in most Olympiads and contests of Mathematics; thus I did not want that the good experience would not be shaded by wrongly chosen studies'.*

The respondents also mentioned *logical thinking*, which witness suitability for exact sciences: *'I always possessed logical thinking, which is an advantage in this speciality'* (the statement of a female-student).

In summary it is possible to state that *in choosing university studies of exact sciences – Physics and Mathematics – as basis for one's professional career both*

personality and social-cultural factors, i.e. sensation of vocation and professional aptitude, as well as encouragement of relatives and good evaluation of future profession's status are especially important for young people. Differences between genders have also become evident: influence and encouragement of a subject teacher, impact of family members and of brothers or sisters is particularly important for female-students. Thus teachers play an important role in motivating and encouraging girls to choose professions, which are related to exact sciences and are traditionally evaluated as a 'masculine' professional field.

Discussion

The purpose of this study was to identify motivating factors as well as career barriers for young people choosing professional career in the fields of Physics and Mathematics in Lithuania. As Ignelzi points, 'Supporting someone's development first requires comprehending and valuing how the other person currently understands his or her experience' (Ignelzi, 2005, 660). Current career literature provides little insight into how women interpret career-relevant experiences, advice, or information, particularly when it is contradictory (Creamer, Laughlin, 2005).

It was also noticed that in our sample, which we acknowledge is small and may not be representative of the general population; the most important is the dimension of self-realization. For female students it means the power, in difference from the male students.

Ozkale et al (2004) examined a sample of undergraduate students in order to identify the factors influencing their engineering 'choice'. There were revealed three groups of factors that made the influence: interest in engineering, desire to become a leader, and scores achieved in university entrance exam (Ozbilgin et al, 2004, 4).

We should agree with Ozbilgin's et al (2004, 22) statement that micro influences as more significant in students' career choices than meso or macro influences. It is also reported that most of the respondents seek career stability. Thus, the findings suggest a stronger belief in the significance of micro–agentic and meso-relational influences on career choices, as opposed to macro-structural constraints (Ozbilgin et al, 2004, 23).

As it was presented in the research, factors influencing professional motivation may not only stimulate career decision making, but also function as career barriers. These career barriers students of Physics and Mathematics stimulate to move from externally focused state to foundation in their journey to self-authorship. In their reflections students remember how they questioned authority so strongly that could move to consider own needs and perspective. This personal perspective we can see from the statements about self-efficacy (Bandura, 1994): students' belief in their capabilities to master academic activities. A key way that self-authorship is demonstrated is when supportive messages like 'you can do anything you want' are no longer accepted because they come from an authority figure, but because they are internalised and integrated as part of one's identity; they become a core self-definition. The process of listening to others' ideas about what kind of career might suit you, weighing it against a core sense of self, and then making a decision is reflected in a critical incident described by one of our participants: 'the teacher of this subject and her teaching influenced my choice most. I used to get thorough

information, which was easy understood. Due to her I understood that this was the subject that intrigued me most; I was sure I could develop as personality if I study it'

Self-efficacy beliefs contribute to motivation in several ways: they determine the goals people set for themselves; how much effort they expend; how long they persevere in the face of difficulties; and their resilience to failures. A large body of evidence shows that explicit, challenging goals enhance and sustain motivation. In our study for female more actual is the motive to prove their competences. This motive they associate with dominant gender and profession stereotypes

Research data show participants experiencing success and being rewarded for learning situated in their own experiences. Fathers and sometime other family members validate their daughters as capable. This is nurturing their daughters' self-authorship. Family environment and family support are important factors in the positive development and socialization of women. Parents serve as significant interpreters for children of information about the world and children's abilities (Hall, Kelly, Hansen, & Gutwein, 1996). The influencers gave the girls and boys a new way of looking at themselves and their options as career seekers. The effect appeared to be deeper than merely a source of career information although that was also part of the relationship in most cases (Meszaros, Burger, & Creamer, 2005). While one girl noted Mathematics' teachers were important as female role models because they validated that women belonged in the field. Experiencing a sense of unity and attachment to parents has been demonstrated to have an impact on adolescents' career development (Bregman & Killen, 1999). Positive experiences both at home and at school seem to have provided the context for these women to reject stereotypical conceptions of women's roles and to adapt a definition of self that is positive, competent, and genuine (Meszaros, Burger, & Creamer, 2005).

Almost none of the respondents identified a counsellor or academic advisor as being influential to their career choice. None mentioned being part of any organized mentoring program. This may be the result of the age of our participants and the lack of these types of programs up to 1.5 to 3 years ago. Guidance counsellors can help parents by meeting with them individually and sharing career resource materials as they discuss how to facilitate their adolescents' career development (Burger & Sandy, 2002). Interventions for parents through parent education programs stressing messages of confidence, a 'can-do' attitude, and a consistent message of the value of education can bolster a girl's confidence in her ability to tackle barriers (Meszaros, Burger & Creamer, 2005).

However, there is not enough with just educational implements. Frome, Alfeld, Eccles & Barber (2006) findings suggest that desire for a flexible job, high time demands of an occupation, and low intrinsic value of physical science were the best predictors of women changing their occupational aspirations out of male dominated fields. Despite the women's movement and more efforts in society to open occupational doors to traditional male-jobs for women, concerns about balancing career and family, together with lower value for science-related domains, continue to steer young women away from occupations in traditionally male-dominated fields, where their abilities and ambitions may lie. These career barriers may be not known for adolescents and students, so they need knowledge about some of the ways that women will achieve both their family and their career aspirations.

Conclusions

Professional motivation conception is worth to add self-authorship development stages as the dynamic element of the model, which would explain carrier barriers nature and possible gender-fair interventions consulting students.

Conclusions

Motives that influenced the choice of Physics and Mathematics were *the wish to enrich own knowledge as well as to develop own thinking, to implement oneself and to distinguish from others; as well as the wish to try oneself and to prove for the environment.* It allows claiming that the most important is the dimension of *self-realization*. The motives oriented to *material achievements*, especially the wish to earn well are also important because the respondents relate hard and exceptional studies to the latter. It was noticed that the motive of the wish to prove for the environment is more important for the female-students; they relate it to the prevailing stereotypes of genders and the profession.

It was also found that both personality and social-cultural factors were important in choosing Physics and Mathematics, i.e. *sensation of vocation* and *professional aptitude*, as well as *encouragement of relatives* and *good evaluation of future profession's status*. Differences between genders have also become evident: influence and encouragement of a subject teacher, impact of family members and of brothers or sisters is particularly important for female-students. Thus teachers play an important role in motivating and encouraging girls to choose professions, which are related to exact sciences and are traditionally evaluated as a 'masculine' professional field.

Career barriers were expressed as two external factors. First, as pressure or a negative influence made by the people that were close to the respondents, striving to dissuade from. Carrier barriers show by two external contributors. First of all, as a pressure or negative impact to the respondents by important to them persons, seeking to persuade from the selection of wanted profession. Here most often was mentioned an influence of a subject teacher, who wanted to prove the possibility to obtain the knowledge of such a difficult field. It is also necessary to stress that female this barrier experienced stronger in comparison to male. Other carrier barrier – stereotype that Physics and Math are not suitable for female – is relevant only to female. Thus, positive experiences both at home and at school have to provide the context to reject stereotypical conceptions of women's roles and to adapt a definition of self that is positive and competent.

From the results overviewed in the article the following recommendations can be brought to the attention of the possible beneficiaries:

- Development of professional motivation should be stimulated already in schools due professional consulting and informing.
- Already in schools career guidance and consultations have to enable students shift from uncritical acceptance of external authority to critical analysis grounded in internal authority, e.g. be able to bring persons internal voices to the foreground to coordinate external influence.
- School counselors, career advisers and especially teachers have to create conditions for intense self-reflection so that persons would be able to articulate 'how I know', considering not only the other's needs but their own needs as well; understanding the importance of positive experiences with making judgments in the development of self-authorship and argumentation of career decisions or barriers seeking to deconstruct occupational stereotypes about sex-appropriate career choices and family roles.
- Strive for that teachers would not follow professional gender stereotypes according women in technological sciences and would encourage girls to develop their professional interests.
- Stimulate and develop consciousness of students in gender equality in order to make them encouraged to bring their own ideas into the decision process and to make judgments about knowledge claims by considering the context and limits of other's perspectives.
- Educate parents to promote self-authorship in girls who want to pursue non-traditional careers helps them to be more resilient facing lack of encouragement because they have developed a solid internal foundation; provide parents with concrete examples about the roles they can play in promoting autonomous career decision making.

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