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Factors for Choosing STEM Career in Middle School Aged Girls: The Case of North Macedonia

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ABSTRACT

This paper investigates the factors related to pursuing STEM career of middle school-aged girls in the Republic of North Macedonia. The underrepresentation of women in STEM, particularly in developing economies, is significant, therefore understanding early career determinants is crucial. Using the Theory of Planned Behavior as the theoretical framework, the study explores the role of attitudes, perceived behavioral control, and subjective norms in shaping STEM intentions. Results indicate that attitudes towards STEM and maternal employment status significantly influence STEM career intentions. Findings emphasize the need for targeted educational interventions that foster positive STEM perceptions and provide role models. These efforts are essential to stimulate interest in STEM, reduce gender disparity, and contribute to economic growth by developing a skilled female workforce.

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Introduction

STEM encompasses a broad field of occupations in science, technology, engineering and mathematics. According to some authors the path towards a country development and transformation towards Industry 4.0 is through enhancing the STEM education and interest (Kamsi et.al., 2019) and yet the enrolment in STEM tertiary education remains low in comparison to fields like business and law (OECD, 2022). The issue becomes of paramount importance in countries like the Republic of North Macedonia faced with several challenges such as underdeveloped market economy and high unemployment rates where women show lower levels of economic activity than men and are more vulnerable to unemployment (European Commission, 2022).

As such, the country needs to stimulate economic development through creation of human capital. Several studies show the importance of good educational attainment on standardized international tests such as Program for International Student Assessment (PISA) and the Trends in International Mathematical and Science Study (TIMSS) and GDP growth (Donovan, 2014; Hanushek, et.al., 2008). In addition, having a STEM career brings personal benefits as employees in STEM earn significantly more than their counterparts in non-STEM occupations and the returns are higher for women than for men (Beede, et.al., 2011).

As such, stimulating the choice of STEM occupations can stimulate economic growth as well as improve the personal financial situation of people in the country. Another important aspect to note when it comes to STEM is the gender gap, meaning than women are far less represented than men in STEM occupations (Stoer and Geary, 2018; UNESCO, 2019; World Economic Forum, 2023). In addition, the enrolment of boys in advanced STEM courses in secondary education is still higher than the enrolment of girls in those same courses (Mullis et.al., 2016). Enrolment in STEM related fields on all levels of tertiary education is still lower for women than for men and they are overrepresented in health, welfare and education sectors (OECD, 2022).

When it comes to females the choice of STEM is related to a number of stereotypes, expectations about gender roles and sociocultural issues (Schina, et.al., 2019). Uncovering the factors that stimulate or suppress STEM interest among girls is quite important as girls and boys have similar performance on generic science literary tests and the percentage of girls who would be successful in STEM is higher than women graduating in STEM meaning that valuable potential is lost (Stoet and Geary, 2018). Certain studies show that the difference in interest in STEM start as early as middle school (Donmez and Idin, 2020).

Therefore, the aim of this paper is to understand the factors relate to choosing STEM related fields in secondary education among middle school aged girls in Republic of North Macedonia. The choice of age is done due to certain studies pointing that stimulating interest in STEM is most effective when done between the ages of 10 and 14 years (Almeda and Beker, 2020; Knezek, et.al., 2013) and that interventions related to instigating interest in STEM would be most effective if they start in primary or middle school since that is the age when children start to get interested in their future careers (San Miguel, et.al., 2019). In addition, educational interventions in that age group seem to be especially successful when it comes to stimulating positive perceptions of STEM among females (Knezek, et.al., 2013). Stimulating the interest in STEM should start early with involvement of a number of actors in the social environment of the pupils like educators and parents (Mahmud, Kari and Ai, 2022). On the other hand, middle school students have limited knowledge about STEM careers and they have hard time connecting their interests in various social activities to STEM careers (Blotnicky, et.al., 2018). In addition, studies point to the complex nature of STEM career orientation among 10 –14-year-olds which means that studying the ways in which STEM orientation can be stimulated in that age group is quite important (Nugent et.al., 2015), with a special accent on finding an approach that will instigate success in STEM related subjects, and boost awareness and interest for STEM careers (Shulga et.al., 2023; Tyler-Wood, et.al., 2018).

Literature Review

Career choice is a complex phenomenon and there are a number of theories used to try to uncover all the intricacies and factors related to career choice. A Systematic Mapping Study with limited scope uncovered that most studies apply the Expectancy-Value Theory (EVT) or Social Cognitive Career Theory (SCCT) which mostly revolve around explaining the psychological (individual) factors for a given career choice (Lopez, et.al., 2023). The EVT accentuates that career choices are made based on the expectation of a achieving success in certain field and how much the person values that success (Wigfield, et.al., 2015). The SCCT connects career choice and students' interests in a career to perceived self-efficacy and outcome expectations (Lent, et.al., 2002). However, the complexities of other factors such as sociocultural factors as well as mediation and moderation effects are

understudied (Lopez, et.al., 2023).

This paper utilizes the Theory of Planned Behavior (TPB) that encompasses both the psychological factors (such as self-efficacy and expectations) and social factors (such as the immediate environment). The cornerstone of the theory is that the people form behavioral intentions for a certain behavior and when opportunity arises are expected to effectuate their intentions (Ajzen, 2012). The intentions capture the motivational aspect of behavior related to the amount of effort an individual is willing to put to realize a certain behavior (Ajzen, 1991). They are especially useful in predicting career choices of young people where the time-frame between the stated intention and actual behavior is longer, as intentions have been shown to be long-run tendencies thus cancelling variation in actual behavior over time (Audet, 2004; Webb and Sheeran, 2006). This predictive power is especially pronounced when it comes to explaining the STEM career choices of females (Moore and Burus, 2019).

According to the TPB (Ajzen, 2012), intentions are dependent on three different beliefs: beliefs about the likely consequences of the behavior, beliefs about the normative expectations of other people and beliefs about positive of negative consequences of behavior (Ajzen, 2002). Behavioral beliefs result in perceived behavioral control which means the extent to which people think that they will be successful in performing a certain behaviour if they want to do so and this is closely related to self-efficacy and also perceived controllability of behavior (Ajzen, 2002). The normative beliefs result in subjective norm which means the perceived social pressure to perform a particular behaviour (Ajzen, 1991). The third type of beliefs result in attitude towards behaviour which means the attractiveness of the outcomes of certain behavior (Ajzen, 2012).

This means that the entrepreneurial intentions are based on the positive or negative personal appraisal about being an entrepreneur (Attitude towards behavior - ATB), perceived difficulty in becoming an entrepreneur (perceived behavioral control - PBC) and perceived approval or disapproval of family, friends and significant other of the decision to become entrepreneur (subjective norm - SN). Various studies have found support for the links between the three beliefs and the STEM intentions. However, the findings are mixed with some studies finding only partial support and some studies failing to find links. It seems that the self-efficacy aspect of the PBC is the most studied aspect as it is studies in various theoretical underpinnings. One exploratory study among primary school students found that females have lower expectancies for success in math and science than males (McMaster, et.al., 2023). The self-efficacy was linked to STEM knowledge, but not directly to STEM career orientation (Nugent, et.al., 2015). Self-efficacy linked to higher interest for a career in certain fields, but the link depends on the subject (Tomperi, et.al., 2022).

Another study of middle school students showed that higher perceived mathematics/science self-efficacy was related to higher likelihood for a STEM career choice in the future (Blotnicky, et.al., 2018). It has to be mentioned that when it comes to gender, a study of 9- to 12-year-olds showed that although girls outperformed boys in programming, their perceived self-efficacy was lower (Schina et.al., 2019). In addition, among girls in secondary schools, self-confidence declines throughout schooling and self-confidence in math and science were related to propensity towards careers in math and science (Siani and Harris, 2023). A large study using female and minority secondary school students in USA found that students in STEM have higher math/science self-efficacy than non-STEM students (Mau and Li, 2018). Although it is not studied as much there is support for the link between ATB and STEM career intentions. For example, one study found that the expectations that STEM career has positive valuation for comfortable personal life was positively related to STEM career orientation (Nugent et.al., 2015). Another study with college students utilizing the TPB found that ATB were strongest predictors of both college major intentions in STEM and career intentions in STEM for both males and females, with the prediction power being greater for females (Moore and Burus, 2019). The link between attitudes and overall choice of STEM was also confirmed in a study with middle school students (Donmez and Idin, 2020). The evidence is mostly positive, but mixed when it comes to subjective norm. For example, one study found that the interest in STEM field for primary school-aged children was related to their perceptions of personal aptitudes and possibility for building relations with STEM professionals with the social relations being more important for girls than for boys (So, Chen and Chow, 2020). In addition, Nugent et.al. (2015) found strong link between the subjective norms and STEM career

orientation. The link was strongest for the educators, followed by parents and then the peers. This shows the importance of providing role models through the educational process as well as supportive home environment in stimulating STEM career choice.

Similar relation between subjective norm and STEM career intentions were shown among college students, with the effect being more pronounced for females (Mishkin, et.al., 2016). Some studies found statistically significant links only for certain groups and not others. For example, one study found that parents and peers have significant influence on STEM career intentions, but teachers do not (Tey, et.al., 2020). Another large study done on female and minority secondary school population in USA showed that higher parental involvement was observed in students who were enrolled in STEM courses than for those in non-STEM courses (Mau and Li, 2018).

Other studies did not find a link between subjective norm and STEM career intentions (Moore and Burus, 2019) but they were done on young adults. The complexity of the career choice is also seen in authors pointing to the moderation/mediation effects of the variables od the TPB. For example, a systematic review of studies found support for the positive effect of self-efficacy on attitudes towards STEM (Potvin and Hasni, 2014). In addition, a study (Mishikin et.al., 2016) found that subjective norms could have positive effect on attitudes towards STEM careers among female college students.

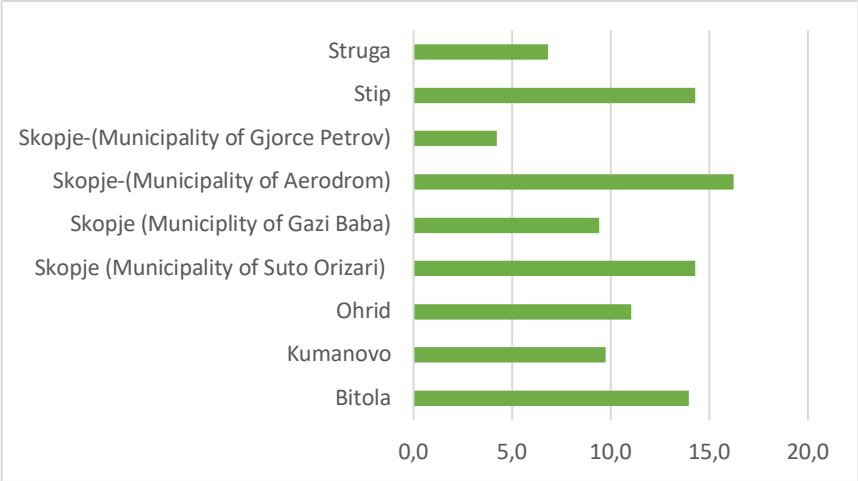

Figure 1. Structure of the sample by region

Methodology

The research was done during 2023/2024 school year. The questionnaire was given to students in May 2023 and they filled it during classes The first part of the questionnaire collected demographic data as well as future schooling options. The next part was dedicated to questions related to the TPB constructs. The questions in this part were adapted from the works: of Linan and Chen (2009), Moore and Burrus (2019), (Moses, et.al, 2020) and Joshi and Kuhn (2011). The questions are adapted on the basis of the works of Linan and Chen (2009), Moore and Burrus (2019) and Joshi and Kuhn (2011). Five-point Likert scale, ranging from “strongly disagree (=1)” to “strongly agree (=5)”, was used for all questions The questions focused on understanding the intentions to pursue a STEM career (3 questions) as long-term stable predictors of behavior, as well as elements of the theory that are important as factors related to intentions. The attitudes toward a behavior were measured with 4 questions. Perceived behavioral control was measured with 3 questions. Subjective norm was measured with 3 questions, whereby the role of family, friends and teachers as important factors in career choice were examined. The third and fourth parts of the questionnaire referred to examining the role of the school and the education system in stimulating the choice of STEM career, and the questions were adapted on the basis of the work of Joshi and Kuhn (2011) and were also answered using a 5-point Likert type scale.

The sample, which was subject to analysis, consists of 308

respondents from 10 primary schools in Macedonia. To ensure that the sample is representative, special attention in the selection of schools was given to the regional component and ethnicity, i.e. the selected primary schools are from Skopje and Skopje area, Stip, Kumanovo, Ohrid, Struga (v.Draslajca) and Bitola. The structure of the sample by regions is presented in figure 1.

Given that the overall project and research are focused on young girls, the sample consists only of females. The average age of students is 14 years. Students from the eighth (23%) and ninth grade (77%) were included, thus their age ranged from 13 to 16 years. Regarding the place of residence, 17.2% are from the rural areas, and 82.8% from urban areas.

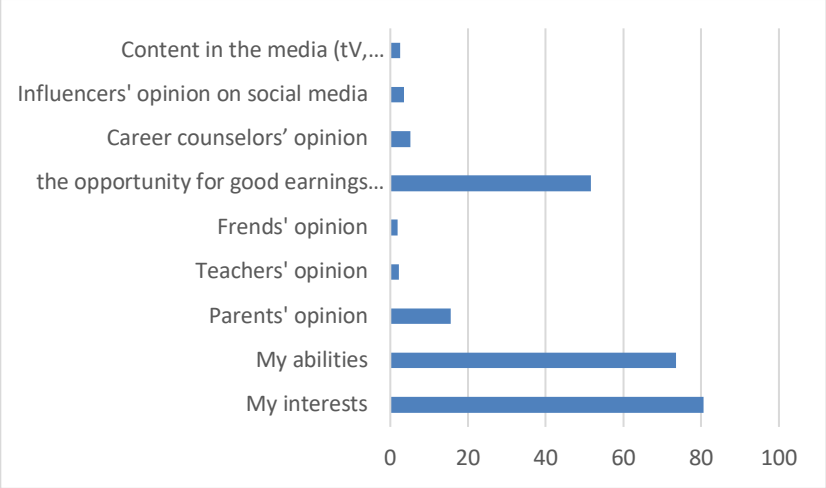

Figure 2. The most important in choosing a career

Examining the share of different ethnicities in the sample, 81.8% speak Macedonian language at home while 18.8% speak one of the languages of the different ethnic minorities who live in the country. Approximately eighty percent of the girls surveyed stated that their mother was employed, and only 31% of them stated that at least one of their parents had a STEM career. Of the girls who stated that at least one parent has a carrier in STEM, 15.6% stated that their father has a STEM career, 10.1% that their mother has a STEM career while 2.5% stated that both parents have career in STEM.

In order to gain insight into the role of different factors in choosing a future career, students were asked to indicate which factors influence their future career choices. Thus, the following factors were listed: my interests, my abilities, parents' opinion, teachers' opinion, friends' opinion, the opportunity for good earnings offered by the profession, career counselors' opinion, influencers' opinion on social media and content in the media (TV, newspapers, movies etc).

Personal interests, abilities and the opportunity of good earnings offered by the profession prevail over the rest of the responses (see figure 2). One of the initial questions in the questionnaire was to determine which field they plan to aspire to for a future career. The students chose between gymnasium and vocational school.

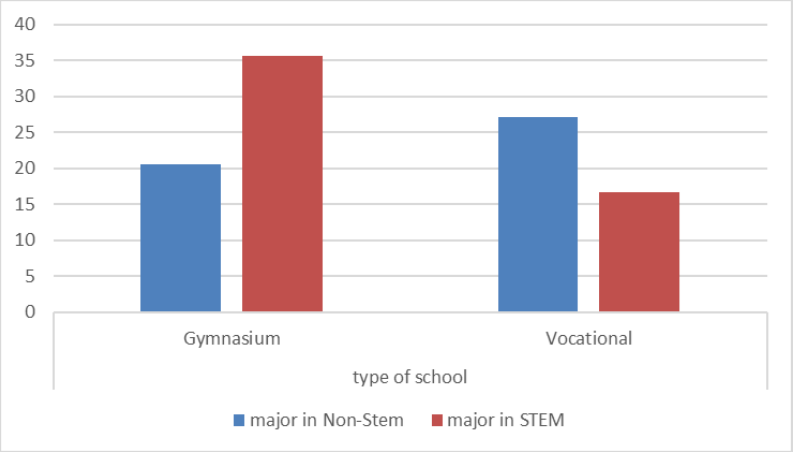

Figure 3. "If I had to choose, I would choose a career in the field"

After the first choice was made, then (in the respected type of school) they choose between major in STEM and major in non-STEM (see figure 3). Majority of the pupils who plan to enroll in gymnasium would like to pursue their career in STEM, while majority of pupils who plan to enroll in vocational school would pursue their career in some non-STEM field. Even more, the pupils are not satisfied by the level of stimulation school does to develop a STEM career (see Table 1). Students positively assess the level of appreciation of women in STEM by the teaching staff (best assessment) and having good grades from STEM courses as driver toward success in the future career.

Slightly positive assessments from pupils towards providing support for the girls to choose a STEM career, motivating both genders in choosing STEM career as well as the student support system for career choice.However, students are neutral when it comes to schools' climate in choosing STEM career, developing skills for a STEM career trough school subjects, and the given emphasis on development of knowledge and skills for a STEM career. On the other hand, students' assessments tend to be slightly negative when it comes to the examples of women in STEM that can be obtained during education.

	1	2	3	4	5
In my school. there is a positive climate about choosing a STEM career	5.2	5.8	22.4	26.3	39.9
In my school. both boys and girls are equally stimulated to choose a STEM career	9.1	12.0	20.5	23.7	34.4
Girls in my school get appropriate support for choosing a STEM career	5.5	4.5	15.6	26.0	48.1
In my school the emphasis is given on development of knowledge and skills for a STEM career	7.8	8.1	24.7	29.9	29.2
Teachers in my school appreciate women in STEM	4.5	2.9	6.2	18.5	67.9
School subjects develop my skills for a STEM career	8.1	10.4	16.2	27.9	37.0
In textbooks and teaching materials there are examples of girls in STEM	16.9	16.9	20.1	26.0	19.8
School teachers make sure to present examples of women with a STEM career	12.0	14.6	23.4	22.1	27.6
School teachers make sure to motivate both boys and girls in choosing a STEM career	9.4	5.5	18.8	20.1	45.8
In my school. there is student support system for career choice	9.1	12.0	17.5	18.5	42.9
If I have good grades from STEM courses it will help me in my future career	4.5	4.2	10.4	14.0	66.9

Table 1. The share of students regarding the statements of school's stimulation for STEM career (in %)

Source: Authors own presentation of the data from the sample

Regarding the students' considerations on building a career in the STEM field, according to the Theory of Planned Behavior, their answers were divided into four main categories, as follows: the intention to build a STEM career, the attitude toward a STEM career, the perceived internal control (the opportunity for success in the given career) and social norms (support from the closest environment, namely parents, teachers and friends) . The ranking of the answers ranged on the scale from 1 to 5 according to the level of agreement with the statements (5 – "I strongly agree"). Results presented in table 2 indicate that students are neutral when it comes to intention to pursue a STEM career, an attitude toward a STEM career, somewhat positive in perceived internal control and positive in social norms especially in the support by the closest environment.

	1	2	3	4	5
Intention to pursue a STEM career	22.3	13.7	19.8	20.0	23.9
Attitude toward a STEM career	15.8	13.0	20.8	24.1	26.2
Perceived Behavioral Control	13.9	13.3	21.9	24.8	25.9
Subjective norm	7.4	7.4	19.3	20.7	44.9

Table 2. Considerations in relation to building a STEM career (in %)

Source: Authors own presentation of the data from the sample

In order to meet the aims and objectives of the paper, a linear regression was established. We regress the dependent variable (a index demonstrating intention to pursue a career in STEM is created as an average of the responses from three questions from the Likert's scale) over a group of factors:

i) Index showing an attitude towards a behavior

ii) Index which presents the perceived behavior control

iii) Index created to present the social norms and the role of the environment on the intentions for choosing a STEM career

iv) Demographic characteristics like age, place of residence, whether their parents have carriers in STEM etc.

Description of the variables used in the regression is presented in Table 3.

Index: Intention to pursue a STEM career (dependent variable)	continous variable: averages from the answers from questions 4.1-4.3 4.1 I would like to enroll in a study program/school that provides a foundation for a career in STEM. 4.2 I would like to have a career in STEM. 4.3 I will work very hard to enroll in a study program/school where I will learn more STEM subjects.
Index:Attitude toward a STEM career	continous variable: averages from the answers from questions 4.4-4.7 4.4 STEM subjects are truly interesting. 4.5 I would enjoy having a career in STEM. 4.6 A career in STEM seems appealing to me. 4.7 If I have the opportunity, I will choose a career in STEM.
Index:Perceived Behavioral Control	continous variable: averages from the answers from questions 4.8-4.10 4.8 I have the knowledge and skills needed for further education and a career in STEM. 4.9 I am good at subjects related to STEM. 4.10 I know that I will be successful in a STEM career.
Index:subjective norm	continous variable: averages from the answers from questions 4.11-4.13 4.11My family believes that a career in STEM is a good choice. 4.12 My friends believe t hat a career in STEM is a good choice. 4.13 My teachers believe that a career in STEM is a good choice.
Age	discrete variable
Grade	dummy variable: 1=9th grade; 0=8th grade
Place of residence	dummy variable: 1=urban area; 0=rural area
Language	dummy variable: 1=macedonian language; 0=other
Employent status of the mother	dummy variable: 1=employed; 0=not employed
Either parent with	dummy variable: 1=yes. 0=no

career in STEM	

Table 3 *Description of the variables*

The econometric specification is as follows:
$Wi=\alpha_i+\beta Ai+\gamma Bi+ \gamma Ci + \delta D_i+\varepsilon i$, i=1 to 308 where,
Wi = index showing intention to pursue a STEM career
Ai = Index showing an attitude towards a behavior
Bi = Index which presents the perceived behavior control
Ci = Index created to present the subjective norms and the role of the environment on the intentions for choosing a STEM career
D_i =set of demographic characteristics
$\mathcal{E}_i$ =error, assumed to be well-behaved.

DISCUSSION

We proceed by presenting the findings from the estimated regression. According to the findings, 64.1% of the variability in the career intentions can be explained by the independent variables (see table B1 in appendix B). All coefficients for all regressions are jointly significant, and coefficients have the expected signs. As Table B3 (Appendix B) shows, following variables are found to have a significant relationship with the intention of the pupil to pursue a career in STEM: attitudes toward a behavior and the employment status of the mother. If the index of attitude toward a behavior increases by 1 then the index of intention to pursue a career in STEM increases by 0.839 units, ceteris paribus. Employed mother also increases the index of intention to pursue a career in STEM by 0.524 units compared to pupils whose mothers are not employed, all other things being equal.

Conclusion

The study found that the girls are quite satisfied with the level of support they are personally getting in pursuing a STEM career and the general positive representation of women in STEM, but quite critical of the study materials and being able to get more examples of women in STEM. The findings of the study point to the link between Attitude towards behavior and Intentions to pursue a career in STEM. This is in line with previous findings (Donmez and Idin, 2020; Moore and Burus, 2019; Nugent et.al., 2015). This implies that having a positive appraisal of the attractiveness of the STEM profession is connected to higher likelihood of wanting to pursue that career among middle school aged girls in the country. The other statistically significant link was found between the employment of the mother and STEM intentions. This is quite valuable as a finding having in mind that the women in the country tend to have higher risk of unemployment (European Commission, 2022).

The findings point that there is a need to create a school environment that will promote and nurture positive attitudes towards STEM in general and also provide stimulations for development of positive attitudes of girls towards STEM. This can be done through carefully crafted curricular interventions, fostering a conducive climate and providing a number of positive examples of women in STEM (Zhou, et.al., 2019). In addition, the link towards employed mother and STEM intentions call for a broader countrywide actions and policies that will enable sustainable female activation on the labor market. This means constructing policy measures to help working women as well as to help with the activation of the inactive women. Future studies on the topic should focus on exploring the complex linkages between various factors and use a representative sample.

COMPETING INTERESTS

The author has no competing interests to declare.

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