Personal Inputs and Contextual Supports as Predictors of STEM Aspirations among Boys and Girls

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Introduction

Background

The STEM (Science, Technology, Engineering and Mathematics) problem is relatively new, emerging and socially very relevant.

The interest of youth for vocations is this field is declining, resulting in shortage of STEM graduates and experts (EU, 2004; Osborne i Dillan, 2008; UNESCO, 2010).

The early formation of STEM interests among boys and girls is particularly important in the context of Croatian educational system, where students have to make their first career decisions at the age of 14, choosing different educational paths.

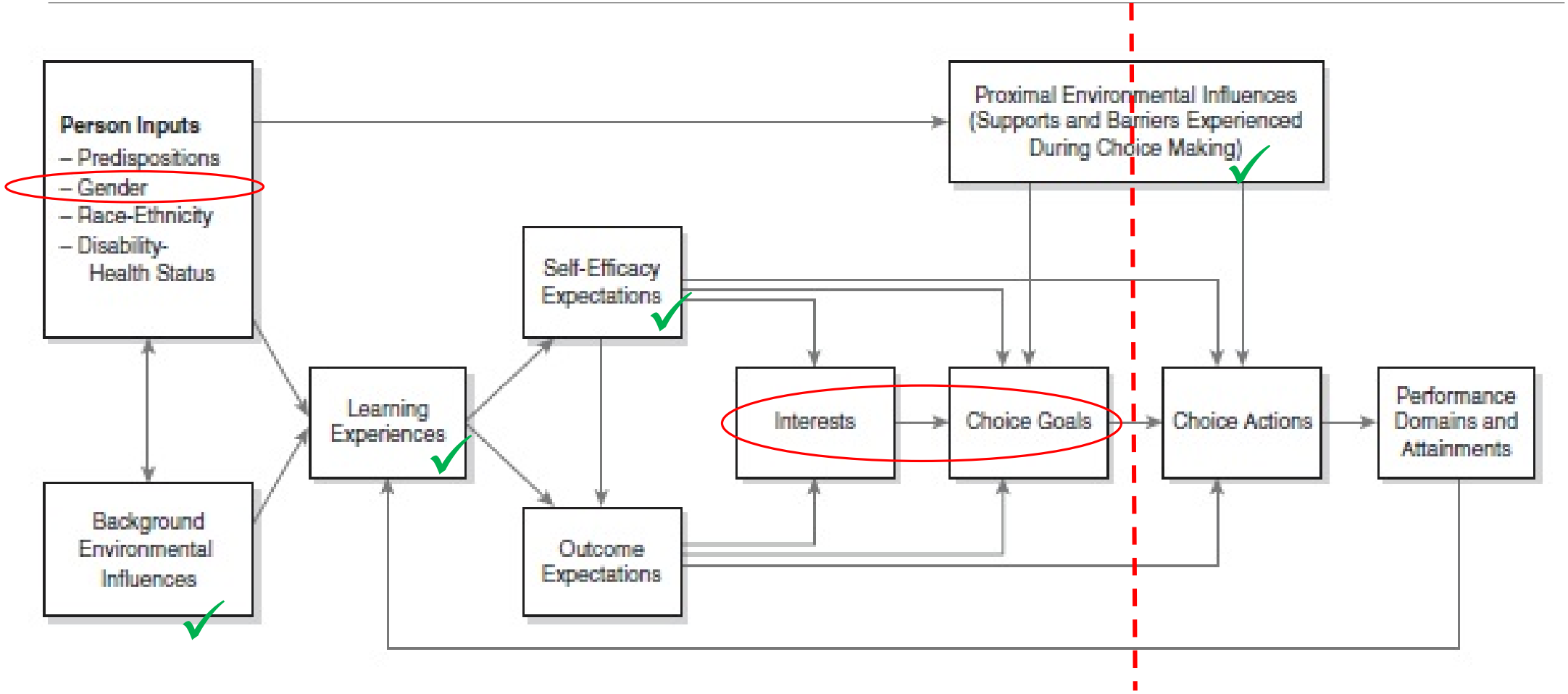
However, the comprehensive studies of problems related to the diminished interest for the STEM field in Croatia have not been carried out.

Background

In this study, we used the Social Cognitive Career Theory (Lent, Brown and Hackett, 1994) as a theoretical framework to predict interest and intention to pursue STEM educational choices and careers among primary school students.

This model encompasses measures of an individual's self-efficacy, outcome expectations, personal inputs and background, and contextual supports and/or barriers to explain reasoning behind students' academic or career choices.

Social Cognitive Career Theory



Gender and STEM

Gender affects STEM interest and career choice.

Studies show that boys and girls differ in their attitudes towards the STEM field (Becker, 1989; Sjoberg & Schreiner, 2005) and interest for STEM school subjects (Murphy & Whitelegg, 2006; Osborne, Simon, & Collins, 2003).

They also differ in their actual STEM career choices, with a smaller number of women than men in these careers (Blickenstaff, 2005; Ceci, Williams, & Barnett, 2009; Gallagher & Kaufman, 2005; Watt & Eccles, 2008).

Some studies showed (e.g., Fredricks & Eccles, 2002; Hyde et al., 1990) that gender differences in academic self-concept mediate career choice and that they are the primary explanation for the diminished interest of women in STEM careers.

Others (e.g., Schreiner and Sjoberg, 2007) proposed that the main reason why young female do not choose careers in engineering and related fields is because they cannot identify themselves with these careers.

The aim of the study

To test the hypothesis that the determinants of STEM career aspirations have different pattern for boys and girls.

We used variables related to students' family characteristics and parental attitudes, peers influences, school achievement, attitudes toward STEM education in school, STEM self-concept, and STEM activities outside the schools in order to predict STEM career aspirations among boys and girls.

Methodology

Respondents

- 360 primary school students attending grades 6 to 8 (age 12 to 15; M=13.32)
- 195 boys and 165 girls
- Convenient sample, three schools in one municipality (Daruvar area), 21 classes

Assessment

- Paper and pencil method was used
- Group assessment, in the classes during the regular school activities
- Data collection lasted 40 minutes

Measures

- Scales used in the survey are mostly derived and adapted from the ASPIRES project (Archer, et al., 2013; DeWitt, et al., 2013).
- Structural validity of all the used scales was checked and items that did not resemble expected and interpretive structure were removed to obtain clear factor structures.
- All scales had acceptable reliability.

Dependent variable

Aspirations toward STEM careers

I like to be:

… a scientist

… an inventor

… a medical doctor, pharmacist or work in field of medicine

… an engineer (e.g. electrical, mechanical, civil)

… a computer programmer, computer network architect or computer systems analyst

… a chemist or work in the laboratory

5 points Likert type scale

Internal reliability: α=.70

Predictors

Parental education status:

- Average of mother and father education level (four points scale)

Parental ambitions/support (scale):

- 7 Likert type items (e.g. My parents want me to go to university; They know how well I'm doing in school) α=.75

Parental attitudes to science (scale):

- 3 Likert type items (e.g. My parents think it is important for me to learn science) α=.57

Positive self-concept in science

- 5 Likert type items (e.g. I do well in science; I learn things quickly in my science lessons) α=.77

Negative self-concept in science

- 3 Likert type items (e.g. I find science difficult; I am just not good at science) α=.78

Attitudes toward school science (scale):

- 7 Likert type items (e.g. We learn interesting things in science lessons; I look forward to my science lessons; science lessons are exciting) α=.78

Predictors

Peer attitudes to science
- 2 Likert type items (e.g. How many of your classmates like science? Think science is cool?) α=.55

Peer orientation to school
- 4 Likert type items (e.g. How many of your classmates care about their marks in school? Encourage you to do well in school?) α=.58

Positive images of scientists (scale):
- 5 Likert type items (e.g. Scientists have exciting jobs; make a lot of money) α=.71

Negative images of scientists (scale):
- 3 Likert type items (e.g. Scientists and people who work in science are odd; do not have other interests) α=.67

Interest for science out of school (scale):
- 6 Likert type items (e.g. Outside of school, how often do you: Read a book or magazine about science? Visit web sites about science?) α=.77

GPA from the previous grade

GPA in STEM subjects in previous grade

Statistical analysis

We applied hierarchical regression analyses separately in boys' and girls' samples in order to predict Aspirations toward STEM careers

Block 1 - Family influences:

- Family education status
- Parental ambitions/support
- Parental attitudes to science

Block 2 - Self-concept in science and attitudes towards science in school:

- Positive self-concept in science
- Negative self-concept in science
- Attitudes toward school science

Statistical analysis

Block 3 - Peer support:

- Peer attitudes to science
- Peer orientation to school

Block 4 - School achievement:

- GPA from the previous grade
- GPA in STEM subjects in previous grade

Block 5 - Out of school STEM attitudes and interests:

- Positive images of scientists
- Negative images of scientists
- Interest for science out of school

Results

Descriptives

	Male		Female		
	M	SD	M	SD	
Aspirations toward STEM careers	2.56	0.85	2.69	0.83	
Family education status	2.71	0.85	2.41	0.78	✓
Parental ambitions/support	4.18	0.47	4.17	0.52	
Parental attitudes to science	3.47	0.73	3.16	0.67	✓
Positive self-concept in science	3.38	0.69	3.37	0.63	
Negative self-concept in science	2.46	0.78	2.44	0.75	
Attitudes toward school science	3.40	0.70	3.41	0.62	
Peer attitudes to science	2.58	0.59	2.43	0.51	✓
Peer orientation to school	3.10	0.65	3.09	0.54	
GPA from the previous grade	4.06	0.81	4.38	0.73	✓
GPA in STEM subjects in previous grade	3.94	0.82	4.17	0.79	✓
Positive images of scientists	3.88	0.56	3.81	0.62	
Negative images of scientists	3.20	0.79	3.19	0.76	
Interest for science out of school	1.63	0.91	1.49	0.86	

✓ p for t-test is <.05

Boys report higher:

- family education status
- parental attitudes to science
- peer attitudes to science

Girls have higher:

- GPA
- GPA in science

Correlations

	Aspirations toward STEM careers	Family education status	Parental ambitions/ support	Parental attitudes to science	Positive self-concept in science	Negative self-concept in science	Attitudes toward school science	Peer attitudes to science	Peer orientation to school	GPA from the previous grade	GPA in STEM subjects	Positive images of scientists	Negative images of scientists	Interest for science out of school
Aspirations toward STEM careers		0.08	**0.17**	**0.16**	**0.37**	**-0.25**	**0.41**	0.00	-0.05	0.13	**0.20**	**0.24**	-0.13	**0.41**
Family education status	**0.23**		0.13	0.08	**0.29**	**-0.28**	**0.18**	0.02	0.01	**0.41**	**0.43**	0.04	-0.01	**0.21**
Parental ambitions/support	**0.18**	0.07		**0.34**	**0.22**	-0.02	**0.22**	0.01	0.07	**0.19**	**0.22**	**0.36**	**0.16**	**0.21**
Parental attitudes to science	**0.25**	**0.13**	**0.51**		**0.26**	**-0.19**	**0.40**	0.04	**0.14**	0.13	**0.15**	**0.26**	-0.10	**0.23**
Positive self-concept in science	**0.42**	**0.28**	**0.29**	**0.34**		**-0.66**	**0.69**	**0.20**	0.04	**0.40**	**0.46**	**0.31**	-0.13	**0.40**
Negative self-concept in science	**-0.50**	**-0.20**	**-0.13**	**-0.13**	**-0.55**		**-0.50**	**-0.32**	-0.02	**-0.47**	**-0.53**	**-0.18**	**0.23**	**-0.30**
Attitudes toward school science	**0.51**	**0.19**	**0.32**	**0.49**	**0.62**	**-0.42**		0.02	0.08	**0.19**	**0.29**	**0.27**	**-0.22**	**0.43**
Peer attitudes to science	**0.26**	0.03	0.01	**0.28**	0.08	**-0.13**	**0.38**		**0.20**	0.05	0.10	0.11	**-0.19**	**0.16**
Peer orientation to school	0.07	0.03	0.04	**0.22**	-0.03	-0.11	0.12	**0.37**		-0.12	**-0.16**	-0.02	-0.10	0.04
GPA from the previous grade	**0.40**	**0.29**	**0.28**	**0.15**	**0.33**	**-0.36**	**0.30**	0.01	-0.12		**0.89**	0.08	-0.09	**0.16**
GPA in STEM subjects	**0.45**	**0.34**	**0.25**	**0.16**	**0.39**	**-0.38**	**0.34**	0.02	**-0.18**	**0.87**		0.13	-0.12	**0.18**
Positive images of scientists	**0.29**	0.07	**0.31**	**0.26**	**0.23**	**-0.32**	**0.34**	**0.20**	0.23	0.11	0.08		0.12	**0.24**
Negative images of scientists	**-0.23**	**-0.13**	-0.01	-0.07	**-0.31**	**0.29**	**-0.27**	**-0.15**	-0.01	**-0.16**	**-0.16**	0.09		**-0.24**
Interest for science out of school	**0.48**	0.11	**0.14**	**0.45**	**0.38**	**-0.36**	**0.45**	**0.29**	**0.15**	**0.13**	**0.22**	**0.23**	-0.10	

p<0.05 is printed boldfaced

Hierarchical regression model

	step 1		step 2		step 3		step 4		step 5	
	male	female	male	female	male	female	male	female	male	female
Family education status	**0.20**	0.06	0.10	-0.03	0.10	-0.04	0.04	-0.03	0.05	-0.06
Parental ambitions/support	0.07	0.13	0.02	0.09	0.04	0.09	0.00	0.09	0.02	0.05
Parental attitudes to science	**0.18**	0.11	0.02	-0.03	0.00	-0.03	0.01	-0.03	-0.09	-0.05
Positive self-concept in science			-0.02	0.16	-0.01	0.14	-0.02	0.15	-0.08	0.13
Negative self-concept in science			**-0.34**	-0.02	**-0.34**	-0.05	**-0.28**	-0.06	**-0.18**	-0.03
Attitudes toward school science			**0.34**	**0.28**	**0.30**	**0.32**	**0.26**	**0.30**	**0.24**	0.18
Peer attitudes to science					0.14	-0.12	0.13	-0.13	0.07	-0.15
Peer orientation to school					-0.05	-0.06	0.00	-0.06	-0.01	-0.04
GPA from the previous grade							0.02	-0.18	0.07	-0.20
GPA in STEM subjects							0.22	0.14	0.17	0.20
Positive images of scientists									0.10	0.08
Negative images of scientists									-0.13	-0.05
Interest for science out of school									**0.26**	**0.27**
R	**0.32**	0.21	**0.61**	**0.43**	**0.62**	**0.46**	**0.65**	**0.46**	**0.69**	**0.53**
R Square	**0.10**	0.04	**0.37**	**0.19**	**0.38**	**0.21**	**0.42**	**0.21**	**0.48**	**0.28**
Adjusted R Square	**0.09**	0.02	**0.34**	**0.15**	**0.35**	**0.16**	**0.38**	**0.16**	**0.44**	**0.21**
R Square Change			**0.26**	**0.14**	0.01	0.02	**0.04**	0.01	**0.06**	**0.07**

p<0.05 is printed boldfaced

Results and discussion

- The regression models in the boys' and girls' samples accounted for different percentage of variance in STEM careers aspirations (R^2=.44 and R^2=.21, respectively).
- The highest incremental validity in both samples was observed for the second block of predictors - Self-concept in science and attitudes toward school science, still substantially higher for boys than for girls (ΔR^2=.26 and ΔR^2=.14, respectively).

- The significant predictors in the final step of regression model were substantially different for boys and for girls:
  - For boys': Interest for science out of school (β=.26); Attitudes toward school science (β=.24), and Negative self-concept in science (β=-.18),
  - For girls': Interest for science out of school (β=.27)

Results and discussion

- Research of DeWitt et al. (2013) partly resembles our results . For example:
  - One of the best predictors of aspirations for STEM careers is Attitudes toward school science.
  - Parental education status, attitudes and ambitions do not play such important role.

- Interesting findings related to differences between boys and girls:
  - In the boys' sample the STEM career aspirations can be much better explained by the used set of predictors
  - Boys interested in STEM careers like science subjects in school, have hobbies related to science, and do not have negative stereotypical images of scientists
  - Girls interested in STEM careers, are highly intrinsically motivated: have hobbies related to science, like school science and have higher marks in STEM subjects then other school subjects.

Conclusions

- In the boys' sample the STEM career aspirations can be better explained by the used set of predictors
- The self-concept in science, engagement in science-related activities outside of school, and images of scientists predict aspirations in science in boys' sample. In girls' sample the used variables are less efficient for prediction of STEM aspirations, and only engagement in science-related activities outside of school is significant predictor.
- Determinants of Aspirations for STEM careers largely differs for boys and girls and should be studied separately.

Limitations

Small and convenient sample

Cross-sectional approach

Pilot study – adaptation of the instruments

Only student's level data were assessed

JOBSTEM project

STEM career aspirations during primary schooling: A cohort-sequential longitudinal study of relations between achievement, self-competence beliefs and career interests

http://www.jobstem.eu

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