



**The contribution of attitudes toward school science in explanation of achievement in STEM school subjects**

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Project sponsor: JUDSTEM project is being fully supported by the Croatian Science Foundation, under the project number JUDSTEM-4022-F-01-2014-BJ-01

**Introduction**

**Background**

Learning in the field of Science, Technology, Engineering, and Mathematics (STEM) is promoted in educational policies of numerous countries. The achievement of students in Croatia in science and mathematics is low in comparison to other school subjects (Burić, Babarović, Šalić, 2008), as well as in international studies (e.g. PISA). The debates about what determines achievement in STEM school subjects in primary school still persist. Several STEM-relevant variables show a significant association with achievement in math and science, including student level variables, school level variables and variables of child's broader social environment (Burić, 2009). Hult's (2003) Transactional Model of the Teaching/Learning Process can be used as a theoretical framework.

**A Transactional Framework of the Teaching/Learning Process**



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A Transactional Framework of the Teaching/Learning Process	
<b>Context</b>	All those factors outside of the classroom that might influence teaching and learning
<b>Input</b>	Those qualities or characteristics of teachers and students that they bring with them to the classroom experience
<b>Classroom Processes</b>	Teacher and student behaviours in the classroom as well as some other variables such as classroom climate and teacher/student relationships
<b>Output</b>	Measures of student learning taken apart from the normal institutional processes

**The input variables**

**STUDENTS' GENDER:**

- a small gender differences in school achievement are found in mathematics (Frost, Hyde, & Feinman, 1994; Hyde, Feinman, & Larson, 1990) and in science (Murphy & Whitelegg, 2006), with girls outperforming boys.
- Girls' and boys' also differ in their motivational orientation to STEM subjects, with girls preferring biological sciences and chemistry, whereas boys are more motivated in physical sciences (Weinburgh, 1995) and in computer-related tasks (e.g. Hayward et al., 2003).

**The context variables**

- FAMILY BACKGROUND**
- research has shown that socioeconomic status (including parental education, employment status and income) is the best predictor of school achievement (Dahl & Lochner, 2005; Milne & Plourde, 2006) and a good predictor of math and science achievement in primary school (Jain, 2006).
- PARENTS' BEHAVIOR**
- parents' involvement in their children's schooling is a powerful predictor of academic success (Gutman & Midgley, 2000; Fan & Chen, 2001).
- INFORMAL, OUT-OF-SCHOOL ACTIVITIES**
- Involvement in STEM out-of-school activities have considerable impact on STEM educational outcomes (Braund & Reiss, 2004)

**The aim of the study**

- To explain how school achievement in STEM school subjects is shaped by structurally different spheres of influence: students' gender, characteristics of home environment and family, leisure activities, hobbies and school activities.
- Taking into account the importance of gender, outside of school context and the family variables, in this research we are looking for evidence that achievement can also be significantly improved by positive experience in formal school contexts.
- More specific aim: To identify the contribution of students' attitudes to school science and experiences with STEM school subjects in explaining STEM school achievement, after controlling individual characteristics, family influences and experience in out-of-school activities.

**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 (Darugar 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.
- Output measure:** STEM school achievement is measured as a composite of school marks (GPA) in different STEM school subjects in the previous grade.

### Measures - predictors

- Student's gender: 1 = male, 2 = female
- 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)  $\alpha = .75$
- Parental attitudes to science (scale): 5 Likert type items (e.g. My parents think it is important for me to learn science)  $\alpha = .57$
- Positive images of scientists (scale): 5 Likert type items (e.g. Scientists have exciting jobs; make a lot of money)  $\alpha = .71$
- Negative images of scientists (scale): 5 Likert type items (e.g. Scientists and people who work in science are odd; do not have other interests)  $\alpha = .67$
- 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?)  $\alpha = .71$
- 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)  $\alpha = .78$

### Statistical analysis

We applied hierarchical regression analysis in order to predict achievement in STEM school subjects.

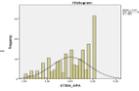
The first block of predictors:

Input and Contextual variables: student's gender, parental education status, parental ambitions/support, parental attitudes to science, positive and negative images of scientists, and interest for science out of school.

The second block:

Attitudes toward school science - added to check if there is a significant increase in explained variance of STEM school achievement.

### Descriptives



	STEM GPA	Parental education	Parental ambitions/support	Parental attitudes to science	Positive images of scientists	Negative images of scientists	Interest for science out of school	Attitudes toward school science
Mean	4.00	2.56	4.66	3.21	3.61	2.17	3.51	3.86
Std. Deviation	0.81	0.83	0.51	0.71	0.63	0.76	0.91	0.68
Minimum	2.00	1.00	1.50	1.00	1.00	1.00	0.00	1.00
Maximum	5.00	4.00	5.00	5.00	5.00	5.00	4.00	5.00

## Results

### Correlations

	STEM GPA	Gender	Parental education	Parental ambitions/support	Parental attitudes to science	Positive images of scientists	Negative images of scientists	Interest for science out of school
Gender	.16							
Parental education	.38*	-.17						
Parental ambitions/support	.26*	.00	.83					
Parental attitudes to science	.13	-.28*	.83	.88*				
Positive images of scientists	-.12	-.03	.07	.87*	.83*			
Negative images of scientists	-.12	.01	-.07	.09	-.06	.61*		
Interest for science out of school	.19	-.08	.16	.19	.87*	.85*	-.14	
Attitudes toward school science	.36*	.02	.18	.28	.46*	.43*	-.07	.87*

p < .05. \*. Correlation is significant at the 0.05 level (2-tailed).

### Hierarchical regression model

	Step 1	Step 2
Gender	.022	.018
Parental education	.046	.020
Parental ambitions/support	.046	.048
Parental attitudes to science	.004	-.030
Positive images of scientists	.027	-.010
Negative images of scientists	-.038	-.089
Interest for science out of school	.016	.002
Attitudes toward school science		.379*
R Square	.016	.166
Adjusted R Square	.010	.162
Sig. Change	.011	.024

Attitudes toward school science explained 5.4% of added variance in STEM achievement, after controlling for personal and context variables.

### Discussion

- Girls are slightly better than boys in STEM school achievement
- The STEM achievement is related to parental education, parental ambitions and support
- It is less related to out of school STEM activities, and perception of scientists
- Attitudes toward school science is important predictor of STEM school achievement
- Attitudes toward school science as "Classroom process variable" adds significant proportion of VAR beyond personal and context variables in explaining STEM school achievement.

