Data-Driven Teacher Professional Development in STEM area: Translating a research based experiences obtained in JOBSTEM research project into everyday school practice

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Funding source: Croatian Science Foundation, grant n° JOBSTEM HRZZ IP-09-2014-9250
JOBSTEM PROJECT: STEM career aspirations during primary schooling: A cohort-sequential longitudinal study of relations between achievement, self-competence beliefs, and career interests

Brings together researchers from:

- Croatia
  - Institute of Social Sciences Ivo Pilar
  - University of Split, Faculty of Philosophy
  - University of Zagreb, Faculty of Electrical Engineering and Computing
  - University of Zagreb, Faculty of Teacher Education

- France
  - Université de Poitiers

- Hungary
  - Central European University

- United States
  - University of California Irvine
The JOBSTEM project: Three main research goals

1. To examine how students’ general and specific STEM career aspirations form and how they change over time

2. To examine how students’ school achievement and self-competence beliefs relate to students’ general and specific STEM vocational preferences and the dynamics of these relations during primary school

3. To examine how students’ general and specific STEM career aspirations are shaped by their families and gender
The longitudinal-sequential design of the study with a two-group pre- and post-test randomized experiment
Participants

- Three cohorts of primary school students in three waves during three consecutive years
JOBSTEM Research Findings
STEM vocational interests in primary school students in Croatia

- Boys show more interest in STEM occupations than girls, with the biggest differences in the fields of Technology and Engineering.

- We explored STEM interests in the context of Holland's model of vocational interests and work environments:
  - Students do not perceive STEM interests as a uniform field of vocational interests.
  - Technology and Engineering interests were shown to mostly fit along the People-Things dimension in RIASEC circular space.
  - Science interests incline to the Ideas pole and Holland's Investigative type.
  - Interests in Mathematics were not sufficiently explained by the RIASEC model.

- There is a large effect size difference in interests towards STEM careers in low and high achieving students in STEM. Lower achievers show substantially lower interests for jobs in STEM area.
Self-concept of the ability in STEM school domains

- Self-concept of the ability in STEM area in Croatian primary school system is shown to be subject-specific, multidimensional construct ➔ students perceive themselves differently competent in Mathematics, Nature, Geography, Informatics, and Technical Education.

- Differences in self-concept of ability in low and high-achievement groups are not consistent across STEM area ➔ this further confirms the multidimensionality of academic self-concept in STEM.

- Students who achieved low on an objective STEM test differed from high achievers the most in the math self-concept of ability.
Gender-stereotyped beliefs about STEM among students

▪ Croatian primary school students endorse the gender-stereotyped belief that STEM subjects are more suitable to boys than to girls ➔ but, small effect size

▪ Boys endorse the stereotype somewhat more than girls

▪ Students who are successful in STEM tended to have stronger stereotypical beliefs about these subjects, irrespective of gender

▪ Interestingly, we discovered interaction between gender and STEM interest in predicting students’ stereotype endorsement ➔ STEM interest and stereotype endorsement were positively associated among boys and negatively associated among girls
STEM extracurricular activities

Preliminary longitudinal results:

▪ Boys are participating more in STEM extracurricular activities than girls → but only in 5th grade
▪ In second wave students reported less extracurricular activities than in the first wave
▪ Cross-lagged relations between participation in STEM extracurricular activities and students’ achievement in STEM school domains:
  o STEM achievement has a effect on the participation in STEM extracurricular activities → very small effect and inconsistent in all three age groups
  o Stabile inter-individual differences in STEM achievement and participation in STEM extracurricular activities across two time points
Transmission of STEM academic values within the family

- Croatian parents on average highly value achievement in the STEM school domains and the usefulness of STEM school subjects, however, it was shown that parental values are weakly related to their children’s importance values of STEM school subjects.

- Path analysis emphasized the role of children’s perceptions of their parents behaviors and values related to STEM:
  - Students’ perceptions of their parents (and not parents’ actual values and self-reported behaviors) best explained students’ own importance value of the STEM school domains.

- The results suggest that parents more easily convey beliefs about the utility of STEM (usefulness of the domain) than the attainment value (importance of doing well on the task).

- Results imply the lack of communicating values in the family through specific parental practices.
Measuring students’ achievement in STEM domains

- Within the JOBSTEM project we developed integrated tests of STEM school knowledge
- Separate tests were developed through grades 4th to 8th
- Current curricular documents related to STEM subjects in Croatia were used in the tests development
- A complete psychometric analysis was conducted so far for the tests for 4th, 5th and 6th grade
  - All three test have unidimensional structure, acceptable reliability, good discriminating power and moderate to high correlations with achievement in STEM school subjects
Qualitative analysis of STEM intervention program

- Students showed the highest interest in the beginning of the program
- Students preferred activities that:
  - Were hands-on type of activities
  - Offered students the opportunity for autonomy and creative freedom
  - Included learning through play
  - Were perceived as more useful in everyday life
  - Emphasized cooperative learning among students
- Most of the students reported more positive attitudes towards STEM after participating in the program, but this effect wasn’t obvious in students who already showed liking for STEM
Qualitative analysis of STEM intervention program

- Students reported decrease in their stereotypical beliefs about STEM experts through increase of the knowledge about STEM careers („I used to think scientists were odd, that they spend the whole day inside and do nothing. But now I do not think so. “)

- Students reported increase in their sense of self-efficacy and subjective value for STEM domains („We have learned how to construct robots and how to program video-games - what we have learned will probably be useful to us in the future.”)

- Very small interest among teachers for conducted activities („Teachers are not interested in what we do outside the school, they only care for grades and tests.”)

- Parents were overall interested in the intervention, but those who are themselves more familiar with STEM area expressed more interest („When I came home, I could not remember chemical ingredients, but my mom and dad are good with chemistry so they reminded me.”)
Implications for teachers
Implications for teachers

Motivational Beliefs in STEM

- Teachers need to be educated on the crucial role of students’ motivational beliefs, like ability self-concepts and interests, for STEM career choices:
  - Importance of separate assessment of students’ beliefs across the STEM area in Croatian educational system
  - Teachers can foster students’ achievement beliefs by building on students’ past experiences, interests, and aspirations
  - School lessons should include discussions about the value of STEM disciplines in the society, but also students’ everyday activities and future
  - Since Croatian low achieving students differ from the high achieving the most in the math self-concept of ability, special attention in the classroom should be given to fostering competence beliefs in math tasks
Implications for teachers

Gender Stereotypes in STEM

Teachers need to be aware of stereotype endorsement in STEM in their classroom. This might help identifying children who are vulnerable to the negative consequences of these beliefs, such as stereotype-consistent behavior among female students.

Participation in out-of-school STEM activities

Students’ participation in out-of-school STEM learning contexts needs to be addressed more frequently in the classroom:

- Informing students about STEM learning opportunities in their local area
- Organizing school trips and visits
- Discussing and encouraging students’ out-of-school STEM activities and habits during regular lessons
Implications for teachers

Collaboration with parents

- Schools and teachers can support parents through educating them about the ways they can successfully communicate value of STEM to their children and about the role these values may play in their children’s educational choices.

- Implementing utility-based STEM interventions in the school-level policies can be beneficial for both parents and students.

Future STEM interventions

Should to take into account students’ need for autonomous and creative learning, include new, hands-on activities and promote team-work and collaboration among students.
Thank you!

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