Qualitative analysis of experience, beliefs, and attitudes of primary school children towards a STEM intervention programme: how to understand outcome and plan future STEM intervention

Authors:

[1]Mirta Blažev

[2]Tomislav Jagušt

[2]Predrag Pale

[2]Juraj Petrović

[3]Josip Burušić*

[1] JOBSTEM project, researcher, Zagreb, Croatia; [2] University of Zagreb, Faculty of Electrical Engineering and Computing, Zagreb, Croatia; [3] Institute of Social Sciences Ivo Pilar, Zagreb, Croatia

Please cite as

Blažev, M., Jagušt, T., Pale, P., Petrović, P. & Burušić, J. (in press), Qualitative analysis of experience, beliefs, and attitudes of primary school children towards a STEM intervention programme: how to understand outcome and plan future STEM intervention. *Napredak*.

* Corresponding author:

Josip Burušić

Ivo Pilar Institute of Social Sciences

Trg Marka Marulića 19/I

10 000 Zagreb, Croatia.

Phone: + 385 1 4886 832.

E-mail: Josip.Burusic@pilar.hr

ORCID https://orcid.org/0000-0002-0933-2189

Funding: This research was supported by the Croatian Science Foundation grant "IP-09-2014-9250 – STEM career aspirations during primary schooling: A cohort-sequential longitudinal study of relations between achievement, self-competence beliefs, and career interests (JOBSTEM)”.

Disclosure statement: The authors state that there are no known conflicts of interest associated with this publication.

Word count: 6756

Abstract

There is an increasing number of science, technology, engineering, and mathematics (STEM) interventions within the education system, and the question of their effectiveness as well as the optimal ways to determine their effectiveness are a growing subject of interest. This study qualitatively evaluates a two-year STEM intervention programme to gain a deeper insight into the students' perception and understanding of STEM intervention. The second aim was to provide some recomendations for planning future interventions in STEM, understanding a provided reason behind students' satisfaction

Four focus group discussions were conducted with students in 4th through 6th grades (N = 24) in 2016 and four focus groups with students in the 5th through 7th grades (N = 34) in 2017. Use of a qualitative approach in the evaluation of the STEM intervention programme proved to be a good choice. The outcome of the analysis show that such a STEM programme could be effective if we maintain the recency effect and interest in the activity, provide as many hands-on activities as possible, increase the sense of autonomy in students, develop collaborative learning, and put emphasis on robot-assisted learning and learning through play. Also, it is important to carry out early STEM interventions, emphasizing the importance and usefulness of the activities for everyday lives of students, and that, during the course of the programme, materials and resources are provided for out-of-school STEM activities (especially for students of lower SES).

Keywords: qualitative evaluation, STEM intervention programme, primary school

Kvalitativna analiza iskustva, vjerovanja i stavova učenika osnovne škole prema STEM intervencijskom programu: ishodi programa i na činjenicama utemeljene preporuke za buduće STEM intervencije

Sažetak

U području prirodoslovlja, tehnologije, inženjerstva i matematike (STEM) postoji sve veći broj pojedinačnih STEM intervencija unutar obrazovnog sustava. Ne čudi stoga da je pitanje njihove učinkovitosti kao i optimalnih načina za utvrđivanje učinkovitosti sve veći predmet interesa.

Cilj je ovog istraživanja evaluirati učinkovitost dvogodišnjeg STEM intervencijskog programa provedenog u osnovim školama, te sagledati njegove efekte na učeničku percepciju, vjerovanja i stavove vezane uz STEM područje. Važan cilj rada je na temelju stečenih empirijskih iskustava pružiti na činjenicama utemeljene preporuke za planiranje budućih intervencija u STEM-u u obrazovnom, školskom i izvanškolskom kontekstu. Provedene su četiri fokus grupe s učenicima od 4. do 6. razreda (N = 24) u 2016. i četiri fokus grupe s učenicima od 5. do 7. razreda (N = 34) u 2017. godini. Uporaba kvalitativnog pristupa u evaluaciji STEM intervencijskog programa pokazala se dobrim odabirom i predstavlja pomak u dosadašnjim evaluacijskim istraživanjima.

Ishod analize ukazuje kako je za učikovitost STEM intervencijskog programa od iznimne važnosti duljina trajanja efekta novosti, održavanje zanimljivosti aktivnosti, količina praktičnog rada, percepcija autonomije autonomije učenika, razina suradničkog učenje te zastupljenost učenja kroz igru ili uz pomoć tehnoloških rješenja. Također, za učinkovitost je važna percepcija važnosti i korisnosti aktivnosti za svakodnevni život učenika te dostupnost sadržaja i izvan školskih aktivnosti učenika (posebice za učenike nižeg SES-a).

Ključne riječi: kvalitativna evaluacija, STEM intervencijski program, osnovna škola

Introduction

In the field of science, technology, engineering, and mathematics (STEM), many STEM school and after-school programmes were designed and implemented. STEM intervention programmes are implemented at different educational levels (pre-school, primary school, and high school as well as undergraduate and graduate university levels and internships), in different contexts (in-school and after-school), through various ways of financing (state agencies, schools, universities, NGOs), using different methods (STEM mentoring and/or tutoring, various summer schools or programmes, career counseling, research experiences, and changes or enrichment in the curriculum), and they aim to achieve different goals (attracting and/or retaining students in a particular STEM school subject or area, increasing academic achievement in STEM school subjects, increasing feelings of students' self-efficacy, and experiencing positive attitudes towards STEM) (Burušić, Blažev, & Dević, 2017). Given the development and existence of a large number of individual STEM intervention programmes, the question of their true reach and overall efficiency has become a matter of concern. Some meta-analysis and review studies have highlighted numerous problems that can be found in designing, implementing, and evaluating different STEM intervention programmes (George-Jackson & Rincon, 2012; Scott-Little, Hamann, & Jurs, 2002; Valla & Williams, 2012). Therefore, the arising question of researchers' interest is determining in what way is a particular STEM intervention programme evaluated in order to better understand its real reach.

By reviewing the existing literature, it is possible to find discussions on a number of methodological challenges and disadvantages in designing and implementing STEM intervention programmes. The most common problems are informal nature of efficacy measurements, absence of control groups, poorly matched comparison groups, absence of randomized grouping and pre-post comparisons, and, in general, lack of data on the effectiveness of measured outcomes in relation to the purpose and goal of the programme (Fashola, 1998; George-Jackson & Rincon, 2012; Scott-Little et al., 2002; Valla & Williams, 2012; Wentzel & Wigfield, 2007). An additional problem is focusing mainly on short-term outcomes of STEM intervention programmes, like learning specific content (Bodin, Elliot, Salami, Hernandez, & de Miranda, 2013; Cotabish, Robinson, Dailey, & Hughes, 2013; Hurtado, Eagan, Figueroa, & Hughes, 2014), experiencing positive emotions (excitement and enthusiasm for STEM) (Deckard, Quarfoot, & Csanadi, 2014), increased confidence in own STEM abilities (Bartsch, Case, & Meerman, 2012; Betz & Schifano, 2000), increased knowledge about the possibilities and value of STEM for different jobs and everyday life (Deckard et al., 2014), and moving the obstacles to potential progress in the STEM area that existed prior to intervention (Myers & Pavel, 2011). Meanwhile, the long-term outcomes of STEM intervention programmes using longitudinal evaluation designs are rarely considered (Valla & Williams, 2012; Wentzel & Wigfield, 2007).

In the relatively short history of STEM intervention programme evaluation, the question of the methodological foundation in the intervention evaluation emerged within quantitative and qualitative methodological approaches, which is generally followed by the question of their possible integration (Lawrenz & Huffman, 2006; Shoffner & Dockery, 2015). The evaluation approach based on the variations of experimental designs using the quantitative approach for the measurement of outcome is considered a gold standard for programme evaluation. Thus, evaluated interventions have shown that the effects of motivational interventions in STEM vary between large effects, small to moderate effects, and no effects at all (Rosenzweig & Wigfield, 2016). However, only such a quantitative approach can be inadequate and disable the real understanding of the outcomes of the programme (Lawrenz & Huffman, 2006).

According to Lawrenz and Huffman (2006), evaluating the outcomes of an intervention through quantitative approach only can generally answer whether and to what extent a STEM intervention programme is successful or unsuccessful. However, what is generally missing is understanding how and why a particular programme is successful or unsuccessful. Authors such as Lawrenz and Huffman (2006) and Blustein et al. (2013) have pointed out the importance of such research in promoting understanding of STEM's interest development. By evaluating the programme with a qualitative approach, it is possible to better understand all the processes through which certain programmes influence STEM interests for at least two reasons. First, quantitative research failed to answer how students construct the meaning about STEM education and career development in the STEM field (Blustein et al., 2013). Second, qualitative research has provided important findings that quantitative research could not obtain. For example, Basu and Barton (2007) found that interest in science in poor urban youth increases when science activities are presented in meaningful and useful ways, when they learn in an environment that encourages social ties important to students, and when they are able to participate in science activities in an autonomous way. Such insights would not be possible with quantitative methods.

The aim of this paper is to make a significant step forward and to carry out a qualitative evaluation of our two-year STEM intervention programme. There are several reasons for this.

We intend to look at and recognize: (1) the latent reasons that could be the basis of satisfaction with the intervention, (2) the latent reasons that could influence the overall outcomes of the intervention, and (3) the possible reasons for the existence or absence of a broader impact of the intervention. Thereby, we want to contribute to scientific valorization of individual programmes and to provide guidelines for designing future programmes in this area. The STEM programme lasted for two years, which enabled us to, comprehensively and over time, monitor student perceptions, which is a departure from the most frequently analyzed, short-term intervention outcomes. Also, using qualitative methodology, we want to make a further step in understanding the potential reasons for (non)effectiveness of STEM programmes. Therefore, we open the possibility for a deeper understanding of the context, experience, and student perception of programme outcomes, which could contribute to a better understanding of quantitative findings in this field of research. By using focus groups, we are moving away from most qualitative evaluation research that uses the techniques of individual interviews (Scott-Little et al., 2002). Given that focus group encourages a wider range of participant responses (Hennink, 2007) and produces original data that are significantly different from individual interviews (opinions expressed under the influence of others, constructing data from multiple sources) (Madriz, 2003), better understanding of the participants' opinions, behaviour, and perception was enabled in relation to most of the existing research.

Evaluated STEM intervention programme

The STEM intervention programme was implemented within the framework of the JOBSTEM project, a four-year longitudinal study of relations between achievement, self-comeptence beliefs, and career interests among students of 16 Croatian primary schools. The project is based on an experimental longitudinal-sequential design that includes three cohorts of primary school students (fourth, fifth, and sixth grades) that are followed during three consecutive years. The students of all schools (N = 2110) are followed with quantitative questionnaires, while those who have gone through the STEM intervention (experimental schools) (n = 1053, 51% boys and 49% girls) are additionaly followed with the qualitative methodology after the interventions. The main goals of the STEM intervention programme were to increase student interest in STEM subjects and careers, to develop positive attitudes towards STEM, and to provide and demonstrate information about STEM careers.

Interventions were carried out on two occasions, i.e., in 2016 and 2017 via multidisciplinary workshops, educational visits to college laboratories, school lectures, and workshops, where students had the opportunity to gain more information about the STEM field and STEM careers, to learn or prove some natural and mathematical laws, and also to restructure and integrate previously learned facts from different school subjects into their corpus of knowledge. School workshops are designed to present new STEM-related content about which students have not been able to hear through regular classes so far, such as content related to robotics, programming, electronics, Internet, etc. In addition to the element of new, interesting content, the implementation of workshops was based on interactive teaching, with the use of interesting equipment and materials for students, and workshops were based on individual and team problem solving from a new field. By visiting STEM-related institutions, the main intention was to enable and show more information about the various careers and jobs in the STEM field. Through lectures, experiments, sites, laboratories, and bureau visits, students have met STEM experts and gained insight into the wide scope of workplaces where STEM experts work and complete daily tasks. The emphasis in this part of the intervention was also to demonstrate connectivity and contribution of the STEM field to a wide range of human activities – to students, it was shown that the discoveries, products, and services developed in the STEM field have an important application in areas such as medicine, the pharmaceutical industry, the food industry, transportation, environmental protection, etc. A more detailed description of the implemented STEM intervention programme can be found in Annex 1.

Method

Participants

Eight qualitative focus groups were formed (6-10 members per group), comprising students of grades 5, 6, and 7. In total, 58 students from eight different schools participated in the research. After the first wave of STEM intervention, four focus groups were held in 2016, and after the second wave in 2017, the remaining four followed.

The researchers were not involved in selection of participants. Students signed up voluntarily for the study, and their teachers were instructed to maintain a balanced distribution of genders in each class and to refrain from selecting only well-behaved and academically successful students. Since every participant of the focus group was directly involved in STEM intervention activities, everyone is considered a valid source of data related to the research.

Procedure for organizing and conducting focus groups

Focus groups were held over the period of May 9 to May 18, 2016, and then from March 21 to March 29, 2017, in the form of semi-structured interviews. The discussions held within the focus groups were approximately the duration of one school period (45 minutes), and they were conducted according to a previously prepared template for a structured conversation. The conversation was divided into three main areas: (1) satisfaction with intervention (satisfaction with activities and suggestions for improvement), (2) outcomes of intervention (change of attitudes, motivation, and knowledge of STEM school subjects and careers and change of perception regarding the appearance of STEM experts and attitudes towards them), and (3) broader effect of intervention (at school and at home). Focus groups were conducted by two moderators, a 34-year-old male and a 28-year-old female. The male moderator conducted half of the focus group, and the female moderator conducted the other half. During every focus group, in addition to the moderator, there was another researcher present who filled the designated form with the student's answers. Every focus group was held in an unoccupied classroom in the school, although a few groups were held in school staff offices. The students were promised anonymity, and the conversation was registered with a voice recorder, with the students' consent. The assistant researchers taking notes were psychology graduate students. Based on the notes and audio recordings, they created transcripts of the conversations that form the basis for future qualitative data analysis. The length of each group's transcript ranged from 9 to 11 pages. In order to protect the students' anonymity, their names are not mentioned in the transcripts, only their pseudonyms, while only the researchers on the project know the students' real identities.

Conceptual and methodological properties of data analysis approach

Framework analysis developed by Ritchie and Spencer in 1994 was used to analyze data. Framework analysis is appropriate for applied research; research with specific, predefined topics; limited time for gathering/collecting data; previously defined sample; and when data collecting has more structure when compared to the one usually employed in qualitative research (Ritchie & Spencer, 1994; Srivastava & Thomson, 2009). Given that our main topics of research and sample (participants of the intervention) are predefined, frame analysis is the most appropriate method of data analysis. Even though frame analysis could help generate theories, its primary task is to describe and interpret what occurs in a specific context, which enables identification of new topics that were not included at the beginning of the analysis (Ritchie & Spencer, 1994). This approach includes a systematic and iterative process consisting of a few different phases: the process of familiarizing with the data, identifying a thematic framework, coding, charting, mapping, and interpreting (Ritchie & Spencer, 1994). Every level of data analysis was first executed by two researchers independently, after which the two sets of results were combined.

Findings and discussion

First we will display findings concerning the reasons behind intervention satisfaction, then the general findings of intervention outcomes, and lastly, we will observe possible reasons behind the broader influence of the intervention.

Satisfaction with intervention

When considering statements regarding satisfaction with the STEM intervention, we can differentiate seven topics that could explain possible reasons for satisfaction with the STEM intervention among students.

The first topic is *The importance of the recency effect and the maintaining of interest in the activity*. The students who are involved in the programme longer show lower satisfaction with the intervention, and there is an increase in the degree of criticism in the students' feedback on intervention content and intervention execution. By contrast, statements provided after the first year were mostly devoid of criticism (*Everything was fine. There isn't anything wrong. It was pretty good.*) This may be due to the fact that, to most students enrolled in first-year activities of the intervention, those were their first extracurricular experiences, something fresh, different, and interesting, which then led to uncritical excitement with those activities. However, when the students were exposed to a similar extracurricular experience again, the recency effect faded away, which had an impact on showing satisfaction with second-year activities. This is very important to consider while designing long-term intervention programmes in which some participants may dropout of the programme, which prevents a complete evaluation of all participants (Francsali, 2002). Hence, it is important to find the optimal method for structuring activities while designing interventions so that the students would be able to maintain interest through time. Additionally, these findings suggest to researchers that they be cautious while interpreting findings of shorter interventions. The positive effects they discover may be a consequence of the recency effect and a lowered degree of student criticism rather than a sign of significant change in the examined characteristic.

The second subject is *The importance of hands-on activities, sense of autonomy, and learning through play*. The results showed that students are most satisfied with segments involving practical activities and content of which they had never heard or seen or with which they had not had the chance to work during regular class. The greatest dissatisfaction was with those activities in which they perceived a lack of practical work (*We were only sightseeing. I wanted to make remote-controlled robots, like the last time.*) or a repetition of the school curriculum they had already experienced or learned during class (*...They explained computer science well, but they only repeated chemistry from school*). That dissatisfaction can mostly be seen when comparing interventions from the first and second year. The ones from the first year were perceived as the ones with more practical work (*I liked when we did more work and less listening last year, and know we listened more and worked less, which made it boring. I want more practical work – like when we had to work with those bridges and that pyramid-tower*). Moreover, it is clear to see that the students wish for those activities in which they have the freedom to create (*They should've let us do more work by ourselves and not have us follow some instructions and wait to see what will happen; ...There should be more stuff where we need to think by ourselves and come up with some kind of solution.*). Therefore, the students are not simply passive participants of the learning process. In fact, they demand to be active and free to create without being bound by previously established rules. That is in accordance with findings from other studies about developing motivation – it is important to design activities with hands-on materials that enable manipulation and interaction with the material along with practical work and activities that support the students' sense of autonomy (Basu & Barton, 2007; Maxwell et al., 2013). By participating in autonomy-enabling activities, that is, by giving children freedom for creativity and allowing them to set their own rules, they become more involved (Maxwell et al., 2013). Additionally, the students express the desire to implement that kind of learning in everyday classes and to integrate play into learning (*I learned everything through play here, while in school I would've learned through class and that's it. That kind of teaching should be done in schools.*) The aforementioned statements clearly show the need for change in school curriculums so that they employ strategies of stimulating autonomy by way of learning through play and hands-on activities that, in turn, lead to a more efficient learning process, greater motivation, and student interest in STEM.

The third subject that emerged was *The importance of robot-assisted learning*. One of the activities in our intervention that caused excitement in the students, one they remembered most and was often singled out as their favourite, is robots. This piece of information is not overly surprising, considering research showing that, by commanding robots, children indirectly learn about programming and engineering in a fun and generalizable way, from which they form an opinion favouring robots as a stimulating and motivating tool in the learning process (Petre & Price, 2004; Sklar, Eguchi, & Johnson, 2003). Even though all our activities included in the intervention were designed to enable learning new content in a fun and playful way, obviously, the robots were the greatest success. This is indeed possible, because robots performed an optimal implementation of both *hands-on* activities and a sense of autonomy. The students studied programming, which in turn resulted in a sense of self-accomplishment – with their own hands, they built something functional they could operate and with which they could later play. Therefore, robots can be a very efficient tool in STEM interventions for directing students towards understanding basic principles of programming and engineering through a sense of autonomy and self-accomplishment.

The fourth topic concerns *The importance of emphasizing the utility-value of activities in everyday life*. Although our intervention programme tried to incorporate a broad spectrum of different STEM areas, students showed greater fondness towards interventions performed in the first year, which were more electronics and computing oriented, because students perceive the area as more useful for their future (*I also liked it better last year because I generally like computer science more than chemistry, which I will never need again in my life*.; *Nowadays, the whole world is built upon this technology concerning new stuff and I think it could be useful, depending on the direction you want to take.*). Research (Rosenzweig & Wigfield, 2016) indicates that not all STEM interventions are equally effective for all STEM areas. There are some areas where the connection between content in class and everyday life is not very clear; therefore, it is necessary to emphasize the connection. If the connection is not highlighted enough, there could be no perceived utility-value of the area in one's everyday or future life. That perceived utility-value is considered the key factor for determining if one develops an interest for a certain area and if it leads to finding a vocation in that area (Eccles & Wigfield, 2002).

The fifth topic revolves around *The importance of collaborative learning*. Students reported greater satisfaction from activities with highlighted orientation towards teamwork and collaboration and expressed a desire for similar activities (*More activities in teams… Like when we built the tower – there were 4 of us and we had to team up.*). This indicates the students' need for learning through interactions with their peers, that is, for collaborative learning. Using that kind of contemporary strategy, the students build knowledge and develop their intellectual abilities, problem solving skills, and critical and creative thinking, and they form emotions and attitudes (Reić-Ercegovac & Jukić, 2008). The research showed multiple advantages of collaborative over individual learning: collaborative learning contributes to better memorization, deeper understanding, higher-order reasoning, critical thinking, greater motivation, and more positive relationships with peers (Laal & Ghodsi, 2012). Thus, when designing future STEM interventions, it is important to include activities that include collaborative learning as much as possible.

The sixth topic is *The importance of conducting early STEM interventions*. In the group discussions, students talked about the need to design these activities for younger students as well (*I would do something like this for younger students too. They should begin with it from the first grade*.), suggesting that these are activities students lacked in their schooling. Recent studies (Rosenzweig & Wigfield, 2016) show a growing need for these types of interventions in younger groups as well, so that students can start developing interests in STEM at an early age. This is something we should emphasize even more, while keeping in mind findings that point out the decrease in interest for STEM areas with higher years of primary education while interest drops even lower after enrollment in high school (Osborne, Simon, & Collins, 2003; Osborne, Simon, & Tytler, 2009; Potvin & Hasni, 2014; Wigfield & Eccles, 1992; Wigfield et al., 1997). Moreover, there are clear indicators that interest in STEM develops until the age of 14 (Osborne et al., 2003; Osborne et al., 2009; Potvin & Hasni, 2014), which highlights an even greater need to intervene before it is too late.

The seventh topic is the *Importance of providing needed materials and resources for engaging in STEM activities outside the intervention, for students with different socioeconomic status.* Students would like to spend their free time involved in these types of activities; however, they often do not have adequate materials and resources for conducting STEM activities in their own homes (*When we see all of that we want to do it ourselves, so we'd like that they give it to us...because we do not have it at home*; *For example, we don't have that connecting magnets, that mechanism, at home*.). Those students who don't have possibilities to engage in activities like this at home are probably less likely to develop interest in STEM areas, in regards to more fortunate students (Eccles & Wigfield, 2002). Therefore, it is of great importance to encourage schools to invest in some STEM activities students could enjoy at home. For instance, one simple and not too expensive solution is an online platform, used in our intervention, which gives teachers the opportunity to organize virtual classrooms that can be used to upload additional materials for their students. In this way, many more students could further participate in STEM activities and develop positive feelings and interests towards them, regardless of their socioeconomic status.

Outcomes of the intervention

At this point we present the factors that could have had an impact on general intervention outcomes as well as those that represent the base of success of other STEM intervention programmes. We identify five possible factors.

The first factor that could be the cause of general outcomes of the intervention is the *Ceiling effect*. Most of the students report positive attitudes towards STEM after taking part in conducted activities (*I always thought that engineering was boring, now I think it is lots of fun*). However, there are students who report similar positive attitudes before and after the intervention took place. These are the students that were interested in STEM from the very beginning (*I didn't change my opinion, I have always been interested in engineering because my dad and uncle are sort of engineers*; *No, because my dad is an engineer and I would always go to work with him when I didn't go to the kindergarten, and I always played with legos and my dad would often send me his plans, which I would copy later on.*). Quotes like these show that there is a different intervention effect for different students and that the intervention itself is not always necessary for all groups of students, which is in line with previous findings (Hulleman & Harackiewicz, 2009; Miyake et al., 2010; Rosenzweig & Wigfield, 2016). Intervention conducted by Hulleman and Harackiewicz (2009) was successful only for those students who initially had low expectations of success. With that in mind, we can expect ceiling effect in motivation for those students who were highly motivated and interested in STEM even before the intervention. Because of that, interventions cannot make much of a difference in their already-positive attitudes towards STEM.

The second factor is the *Decrease in stereotypes about scientists*. Our analysis showed that students report fewer stereotypes about scientists after receiving information about STEM professions, meeting STEM experts, and visiting their workplaces. By taking part in these activities, students learned a lot about STEM vocations and their typical work tasks (*Now I know much more about what they do. I thought that engineers work only with computers, but now I know they can also program and build robots – which is nice to see*), which resulted in a decrease in some stereotypes students had about STEM vocations (*We learned more about these vocations, now they seem more normal than I thought they were*), positive changes in students' attitudes towards scientists and engineers (*Now we can respect their work more, people usually think that scientists don't get much recognition, that their work is not that much important, but now that we see what and how much they work and contribute to the world around us, we can change our opinion*), and a decrease in stereotypes towards them. Some studies that used the *Draw a scientist* test revealed certain stereotypes that students usually have about scientists as being older men who wear white lab coats and glasses, typically have beards, enjoy working alone, rarely hang out with other people, are surrounded by various equipment, work in a lab, conduct dangerous experiments, and behave rather eccentrically (Mead & Metraux, 1957). Findings of our study show that students indeed had these or similar stereotypes towards scientists, which were reduced after meeting real scientists and seeing environments in which they work (*I thought they were crazy scientists who are always inside and don't ever hang out with other people. Now I have changed my opinion*.; *I thought that scientists are old people. But apparently, not all of them are old.*; *Scientists, I imagined them as very smart, wearing glasses. Now I know they are indeed very smart, but they don't wear glasses.*; *In movies, crazy scientists, with crazy white hair, silly blouse and glasses, but now I'm left with a much more positive impression*.).

As a third factor, it is important to mention *Mastery experience, self-efficacy, and subjective task value*. Activities were designed in a way to give students a much-needed practical experience and hands-on activities that enable students to acquire mastery experience, which is, according to Albert Bandura (1997), one of four sources of self-efficacy in his theory. Previous studies suggested that one of the main factors involved in development of interest towards a specific area is the feeling of self-efficacy in that area. If a person believes in his/her own abilities to achieve a specific goal, it is more likely he/she will engage in meaningful activities, while putting forth more effort and being more persistent in achieving that goal (Bandura, 1997). During discussions, students reported obtaining more knowledge and skills related to STEM, and it is clear that they now feel more self-efficient and ready to engage in activities related to STEM (*In the beginning of the fifth grade, we came across biology, geography, and maths for the first time and I didn't want to start. I thought that geography would be very difficult. While visiting the institute, I figured it's not that hard after all, and now I am among the best students in the class*; *I realized that logical things are easy to learn – for example, when I don't want to study, it would be great if someone would give me logical games or something like that to help me learn*; *I think that now we are better at it than before – I really liked everything, and I didn't even think about robots until I saw them at Faculty of Electrical*

Engineering and Computing, but now I decided to buy one of these and try putting it together by myself.). One more determinantal factor in development of interest in a specific area is the subjective task value, or in other words, students' beliefs about being engaged in a certain activity where they are doing something worthwhile (Eccles & Wigfield, 2002). Without it, although a student could believe he/she could be successful in performing a certain activity, he/she still might not be interested in it. Hence, both perceived high self-efficacy and personal value of STEM areas are important in order for students to choose a STEM profession. We generally rate a specific task as valuable when we perceive it as interesting, important, or useful (Eccles & Wigfield, 2002). In our study, students see STEM activities as valuable and believe they acquired new skills that could be useful for their everyday life (*We learned how to build robots and program – we might need that knowledge in the future*.). Similarly, they see STEM as more important and show greater interest for STEM areas (*I think I could study something like that when I grow up. Now I study more than before, so I could go to college and have a career in this area*.). Some students show interest in future education in STEM, since they enjoyed and experienced feelings of personal achievement that, in return, increased their competence beliefs (*I would like to study there because I found everything very interesting. I can see I could manage there as well*.). Hence, if we want to help students develop interest and aspire STEM professions, activities in doing so should be designed in a way to encourage students' self-efficacy (specifically mastery experience) and increase the subjective value students put on these activities (interest, importance, usefulness).

The fourth factor is *The participation of girls and boys in intervention*. One of the interesting outcomes is that the girls, according to the perception of boys, showed greater interest in STEM than they first had (*Girls became more interested in STEM than they were before – my friend who was always talking about how she doesn't like math got very excited when we were in groups, and she was trying really hard and thought about what she wanted to be*). Studies have shown that girls show less interest in STEM, have lower perceived self-efficacy in STEM, and choose such activities much less often, because they believe that STEM is not suitable for women (Brandell & Staberg, 2008; Catsambis, 1995; Eccles, 2007; Frome, Alfeld, Eccles, & Barber, 2006; Lippa, 2005; Su, Rounds, & Armstrong, 2009). Specifically, the STEM field is perceived as a highly masculine field, due to the presence of widely accepted gender stereotypes, which reduces interest in STEM among girls while increasing it among boys (Brandell & Staberg, 2008; Eccles, 2007). Various interventional studies have shown that, by reducing stereotype threat, interest in STEM among girls increases (Jansen & Joukes, 2012;

Miyake et al., 2010). Through different practical activities in our intervention, girls were given the opportunity to increase their own STEM self-efficacy and also sense of identification and belonging to STEM areas, which cuts down negative consequences of the stereotype threat. Given that both boys and girls participated in our intervention at the same time, there was an opportunity for boys as well to reduce their stereotypes about STEM as a mere male field and, through the interaction with girls in STEM activities, realize that this is something in which girls can also successfully participate. Therefore, it is important to design STEM intervention programmes so that girls and boys are both involved in it at the same time.

For the fifth factor, we would like to single out *STEM capital*. Students' testimonies indicate how important science capital is for developing interest in STEM (*...because my dad is an engineer and I would always go to work with him when I didn't go to the kindergarten, and I always played with legos and my dad would often send me his plans, which I would copy later*). This is in line with some other studies (Archer et al., 2012; Archer, Dawson, DeWitt, Seakins, & Wong, 2015; Aschbacher, Li, & Roth, 2010), suggesting that children who have parents with higher science capital (for example, parents with education or profession in a STEM area) have higher achievement in science and show greater aspiration for science. Therefore it is important, when increasing the interest in STEM among students, to take into account the STEM capital of parents when designing related activities. This may require more interventions and focus on those students who do not have large STEM capital.

Broader influence of intervention

Finally, it is very important to use the qualitative approach when reviewing possible reasons that may generally exist in the basis of a broader impact of STEM intervention programmes, and they can be an obstacle to the broader, longer-lasting, and more comprehensive impact of STEM interventional activities.

The first reason could be the *Insufficient interest of socialization role models*. Research shows that socialization models, i.e., teachers and parents, play an important role in the formation of STEM interests in children (Eccles & Wigfield, 2002; Fennema, Wolleat, Pedro, & Becker, 1981; Jansen & Joukes, 2012). Depending on what parents or teachers think about the importance of the STEM field and the children's abilities, and depending on what messages they send to children, it greatly influences whether children develop interest in STEM (Archer et al., 2012; Aschbacher et al., 2010; Eccles, 1992; Frome & Eccles, 1998; Jacobs & Eccles, 2000; Keller, 2001). During the group discussions, students reported that neither teachers nor parents showed excessive interest in the activities they had experienced. According to student perceptions, teachers commented on their activities only during homeroom class, by commenting on students' behaviour and asking general questions about what children liked during the visit (*None of the teachers showed any interest more than a question about how it was, and that was all and then we needed to continue with the lecture.*). Teachers of STEM subjects did not use the intervention to ask additional questions about the STEM field or the content of the intervention to connect or deepen teaching material. Thus, school associates did not use the intervention for career counseling to counsel the students about their future occupations. The above mentioned can represent a problem if it is taken into account that career counselors in schools can play a key role in guiding students towards future occupations. However, a particularly interesting finding is that students notice the lack of teachers' interest in their extracurricular activities (*Professors do not show interest in what we do outside school, but only for grades and exams*) and express the desire for greater teacher interest in their extracurricular activities (*I would include teachers to participate more. I wish we meet each other more often – so we visit you and you visit us more often and that parents and teachers participate in these projects.*). Likewise, they would like their teachers to adopt the teaching strategies they have experienced in the intervention programme (*I would also like the teachers to go to that lecture. That they go to the lecture by themselves. I would like that a lecture is arranged for them so they can see this way of teaching others and get to know it a little bit better and maybe start to teach us in a different way.*). The aforementioned indicates the importance of designing STEM interventions by including parents, teachers, and school staff.

Another reason is *STEM capital*. It has been shown that parents with more knowledge and experience in STEM asked their children more detailed questions about their activities and in that way showed greater interest (*My dad studied at FER [Faculty of Electrical Engineering and Computing] so he was asking me more.*; *When I came home I could not remember the ingredients, and my mom and dad know chemistry so they reminded me of them.; My parents were glad because I was interested in that and that I was going to it at all, and my grandpa was even more glad because he had worked there before.*). Also, the importance of parental science capital stands out in developing STEM interests in children (Archer et al., 2012; Archer et al., 2015; Aschbacher et al., 2010). This is especially indicated by the students' statements during group discussions (*My parents usually encourage me to work with that electronics and to go to these visits, and when they heard what we were doing there, both my parents and I were interested even more.)* From the previous statement, it can be seen that parental encouragement has a positive impact on the child's interest. Some students stated that their parents did not ask them anything, because they do not understand the STEM field (*My father and my stepfather asked me, but my mom didn't because she doesn't understand that. Or maybe she does, but she forgot.*). Families and family characteristics play an important role in forming achievements, involvement, aspiration, and interest in science among students (Aschbacher et al., 2010). In addition, positive parental attitudes towards science are strongly associated with greater children's aspirations in science (Archer et al., 2012; Archer et al., 2015). Therefore, it is important to include all of the profiles of parents in more active participation in the STEM intervention programme, which would help the students to profit further. For example, a relatively simple STEM intervention conducted on the parents turned out to be useful for the development of STEM interest in children (Harackiewicz, Rozek, Hulleman, & Hyde, 2012). Harackiewicz et al. (2012), with their intervention research, have shown that, by providing information to parents about the usefulness of mathematics and science contents in everyday life, their perception of the value and usefulness of STEM subjects increases; communication with their children about the value and usefulness of the STEM subject also increases; and finally, the number of students that, during the last two years of high school, choose the STEM subjects on their own also increases.

Conclusion

The analysis of qualitative data taken in the context of the evaluation of this JOBSTEM intervention programme clearly gave us insights into the reasons that contributed to student satisfaction with the intervention, answered the question of what influences the outcomes of the intervention programme, and provided clear guidelines for what is important to consider if the broader impact of the intervention programme is to be achieved in all future interventions in the STEM field.

The findings of this qualitative research indicate that, while designing long-term intervention programmes, ensuring the longer duration of the recency effect is important to maintain interesting activities, to organize practical teamwork activities, to assure the feeling of autonomy in activities and learning through play, to emphasize the importance and usefulness of activities for students' everyday life, to provide materials and resources for STEM activities at home for students of lower SES, and to move towards younger age groups. If one wants to achieve the best outcomes of the intervention, the targeted group of students who participate in the intervention should be considered. Interventions for students who initially have high STEM interest are probably not effective, due to the ceiling effect. Likewise, more attention should be paid to students with less STEM capital than those who have more. If one wants to reduce some of the existing stereotypes about scientists, it is important to structure the interventions by bringing students into contact with STEM experts and their workplaces. Additionally, if the will is to send a message that STEM is something that is equal for girls and boys, it is important to include both groups of students – girls and boys – in the intervention programmes. Also, it is important to design all activities in order to ensure a mastery experience, self-efficacy, and greater activity value for students. The preparation of the STEM intervention programme for students is unlikely to have a broader impact, other than on the students themselves. Therefore, if the broader impact of the intervention is to be achieved, it is important to involve teachers, school staff (career counselors, psychologists, or pedagogues in school), and parents alike. It is particularly important to provide the above mentioned to students who have parents of lower STEM capital and design interventions that would help strengthen it.

Annex 1. *Description of STEM intervention programme*

Order of intervention	Date of intervention	Type of intervention	Duration (h)	Description of activities
First intervention	13.-22.01.2016	Multidisciplinary workshop	0.45	- Classical presentation, two-way communication through questions and answers, mini experiments and hands-on interactive workshops that aimed to answer the question "What do scientists do, and is science interesting?" - The students are introduced with: o wide range of STEM fields – from math and physics to programming and robotics; o fractals and potentials of the number two through the problem of bending the paper; o programming in a visual programming language Scratch; o basic terms of electricity and electromagnetism. - Programmable robots were presented to them. - An online platform was presented to them where virtual classrooms were organized, and additional contents were published (motivational movies, organized galleries of student digital drawings, etc.).
Second intervention	03.-26.02.2016	Visit to scientific and higher education institutions: Faculty of Electrical Engineering and Computing (FER)	3	- Visit to laboratories for: o robotics and intelligent LARICS system; o underwater systems and LAPOST technology; o LARES renewable energy systems. - Visit to institutes for: o electronic system and information processing; o electroacoustics; o telecommunications. - Students were managing the aircrafts, robots, tanks, and car toys. - Two specially designed workshops for students: o Robots – students compile and programme robots, learning the basics of robotics and computer programming. o Programming workshop in Scratch Programming Language, which introduced the students to basic concepts and principles of computer programming and algorithmic problem solving.

				- Students also tried interactive entertainment games embedded in educational tools on the code.org and lightbot.com web platforms, through which they learned about the basic parts of each computer program.
Third intervention	04.-11.04.2016	Multidisciplinary workshop	1.5	- The students themselves made objects and characters of paper to get acquainted with certain laws of physics.
Fourth intervention	08.11.-07.12.2016	Multidisciplinary workshop	1.5	- The students participated in two workshops: ○ "Computer Networks and Internet" was conducted as a combination of lectures, discussions, research, and practical exercises that presented the functioning and complexity of computer networks and the Internet in an interesting and clearly understandable way to students. ○ The electronic-robotic workshop is a combination of content from the basics of electronics and robotics. Educational sets that contain different colored electronic components are used in this workshop. These components are coupled by magnets and are clamped into sequences (closed circuits), enabling students to learn the basic principles of electronics and functioning of various components in a set in a simple and presentable way.
Fifth intervention	24.01.-15.02.2017	Visit to scientific and higher education institutions: Faculty of Mechanical Engineering and Naval Architecture (FSB), Faculty of Chemical Engineering (FKIT), Ruđer Bošković Institute (IRB)	3	-FSB: ○ The students visited some of the faculty laboratories where they were introduced, through expertly conducted demonstrations and short lectures, to various fields of mechanical engineering, shipbuilding and aviation, research conducted in laboratories, and application of technical solutions in wide areas of human activity. -FKIT: ○ The students visited three faculty institutes: the Department of Organic Chemistry, the Department of Analytical Chemistry, and the Department of Mechanical and Thermal Process Engineering. Students in small groups went through a number of interesting exercises, experiments, and demonstrations, with the guidance of faculty professors and assistants. -IRB: ○ The students participated in several workshops in the field of biology, chemistry, physics, and environmental science.

Acknowledgments

This research was supported by the Croatian Science Foundation grant “IP-09-2014-9250 – STEM career aspirations during primary schooling: A cohort-sequential longitudinal study of relations between achievement, self-competence beliefs, and career interests (JOBSTEM)”.

References

Archer, L., Dawson, E., DeWitt, J., Seakins, A, & Wong, B. (2015). ''Science Capital'': A Conceptual, Methodological, and Empirical Argument for Extending Bourdieusian Notions of Capital Beyond the Arts. *Journal of Research in Science Teaching, 52*(7), 922-948. doi:10.1002/tea.21227

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2012). Science Aspirations, Capital, and Family Habitus: How Families Shape Children's Engagement and Identification with Science. *American Educational Research Journal, 49*(5), 881-908.

Aschbacher, P. R., Li, E., & Roth, E. J. (2010). Is science me? High school students' identities, participation and aspirations in science, engineering, and medicine. *Journal of Research in Science Teaching, 47*, 564–582.

Bandura, A. (1997). Self-Efficacy: *The exercise of control*. New York: W. H. Freeman and Company.

Bartsch, R. A., Case, K. A., & Meerman, H. (2012). Increasing Academic Self-Efficacy in Statistics With a Live Vicarious Experience Presentation. *Teaching of Psychology, 39*(2), 133-136.

Basu, S. J., & Barton, A. C. (2007). Developing a sustained interest in science among urban minority youth. *Journal of Research in Science Teaching, 44*, 466–489.

Betz, N. E., & Schifano, R. S. (2000). Evaluation of an Intervention to Increase Realistic Self-Efficacy and Interests in College Women. *Journal of Vocational Behavior, 56*, 35-52. doi:10.1006/jvbe.1999.1690

Blustein, D. L., Barnett, M., Mark, S., Depot, M., Lovering, M., Lee, Y., . . . DeBay, D. (2013). Examining urban students' constructions of STEM/career development intervention over time. *Journal of Career Development, 40*, 40–67. doi:10.1177/0894845312441680

Bodin, R., Elliott, J. Salami, M. A., Hernandez, P. R., & de Miranda, M. A. (2013, April). *The Effects of a Complex Classroom Intervention on Students' Perceptions in STEM Courses*. Presentation at the Annual Rocky Mountain Psychology Association. Denver, CO.

Brandell, G., & Staberg, E. M. (2008). Mathematics: a female, male or gender-neutral domain? A study of attitudes among students at secondary level. *Gender and Education, 20*(5), 495-509.

Burušić, J., Blažev, M., & Dević, I. (2017). STEM intervention programs in school and out-of-school settings: overview, practices and challenges. *Napredak, 158*(4), 148-502.

Catsambis, S. (1995). Gender, race, ethnicity, and science education in the middle grades. *Journal of Research in Science Teaching, 32*(3), 243-257.

Cotabish, A., Robinson, A., Dailey, D., & Hughes, G. (2013). The effects of a STEM intervention on elementary students' science knowledge and skills. *School Science and Mathematics, 113*(5), 215-226. doi:10.1111/ssm.12023

Deckard, C., Quarfoot, D., & Csanadi, K. C. (2014, June). *Analysis of a Short-Term STEM Intervention Targeting Middle School Girls and Their Parents (Research to Practice)*. Presentation at the 2014 ASEE Annual Conference. Indianapolis, Indiana.

Eccles, J. S. (2007). Where are all the women? Gender differences in Participation in Physical Science and Engineering. In S. J. Ceci. i W. M. Williams (Eds.), *Why aren't more women in science? - Top researchers debate the evidence* (pp. 199-210). Washington (DC): American Psychological Association.

Eccles, J. S. (1992). School and family effects on the ontogeny of children's interests, self-perceptions, and activity choices. *Developmental Perspectives on Motivation, 40*, 145-208.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology*, *53*, 109-132.

Fashola, O. S. (1998). *Review of extended-day and after-school programs and their effectiveness*. Report no. 24. Baltimore, MD: Center for Research on the Education of Students Placed at Risk.

Fennema, E., Wolleat, P. L., Pedro, D., & Becker, A. D. (1981). Increasing Women's Participation in Mathematics: An Intervention Study. *Journal for Research in Mathematics Education, 12*(1), 3-14.

Francsali, C. (2002). *What we know about girls, STEM, and Afterschool Programs*. Prepared for Educational Equity Concepts. New York: Academy for Educational development. Retrieved from https://secwww.jhuapl.edu/MESA/Content/Docs/whatweknow.pdf

Frome, P. M., Alfeld, C. J., Eccles, J. S., & Barber, B. L. (2006). Why don't they want a male-dominated job? An investigation of young women who changed their occupational aspirations. *Educational Research and Evaluation, 12*(4), 359-372.

Frome, P. M., & Eccles, J. S. (1998). Parents' influence on children's achievement-related perceptions. *Journal of Personality and Social Psychology, 74*(2), 435-452. doi:10.1037/0022-3514.74.2.435

George-Jackson, C. E., & Rincon, B. (2012). Increasing sustainability of STEM intervention programs through evaluation. *Advancing the STEM agenda: Quality improvement supports STEM*, *5*(1), 249-266.

Harackiewicz, J. M., Rozek, C. S., Hulleman, C. S., & Hyde, J. S. (2012). Helping parents to motivate adolescents in mathematics and science: An experimental test of a utility-value intervention. *Psychological Science, 23*(8), 899 –906. doi:10.1177/0956797611435530

Hennink, M. M. (2007). *International focus group research: A handbook for the health and social sciences*. Cambridge University Press: Cambridge.

Hulleman, C. S., & Harackiewicz, J. M. (2009). Promoting Interest and Performance in High School Science Classes. *Science, 326*(5958), 1410-1412. doi:10.1126/science.1177067

Hurtado, S., Eagan, K., Figueroa, T., & Hughes B. (2014). *The Impact of Undergraduate Interventions on STEM Student Outcomes*. Los Angeles: Higher Education Research Institute, UCLA.

Jacobs, J. E., & Eccles, J. S. (2000). Parents, task values, and real-life achievement related choices. In C. Sansone, J.M. Harackiewicz (Eds.), *Intrinsic and extrinsic motivation: The search for optimal motivation and performance* (pp. 405-439). San Diego: Academic Press.

Jansen, N., & Joukes, G. (2012). Long Term, Interrelated Interventions to Increase Women's Participation in STEM in the Netherlands. *International Journal of Gender, Science and Technology, 5*(3), 305-316.

Keller, C. (2001). Effect of Teachers' Stereotyping on Students' Stereotyping of Mathematics as a Male Domain. *The Journal of Social Psychology, 141*(2), 165-173. doi:10.1080/00224540109600544

Laal, M., & Ghodsi, S. M. (2012). Benefits of collaborative learning. *Procedia-Social and Behavioral Sciences, 31*, 486-490.

Lawrenz, F., & Huffman, D. (2006). Methodological Pluralism: The Gold Standard of STEM Evaluation. *New Directions for Evaluation, 109*, 19-34. doi:10.1002/ev.176

Lippa, R. A. (2005). Subdomains of gender-related occupational interests: Do they form a cohesive bipolar M-F dimension? *Journal of Personality, 73*, 693–729.

Madriz, E. (2003). Focus groups in feminist research. In N. Denzin & Y. Lincoln (Eds.), *Collecting and Interpreting Qualitative Materials* (2nd ed., pp. 363–387). London: Sage.

Maxwell, A., Fogarty, R., Gibbins, P., Noble, K., Kist, A. A., & Midgley, W. (2013*). Robot RAL-ly International – Promoting STEM in elementary school across international boundaries using remote access technology*. Paper presented at the Proceedings of the 10th International Conference on Remote Engineering and Virtual Instrumentation (REV 2013), pp. 1-5, IEEE.

Mead, M., & Metraux, R. (1957). Image of the Scientist among High-School Students: A Pilot Study. *Science, 126*, 384-390.

Miyake, A., Kost-Smith, L. E., Finkelstein, N. D., Pollock, S. J., Cohen, G. L., & Ito, T. A. (2010). Reducing the Gender Achievement Gap in College Science: A Classroom Study of Values Affirmation. *Science, 330*(6008), 1234-1237. doi:10.1126/science.1195996

Myers, C. B., & Pavel, M. C. (2011). Underrepresented students in stem: the transition from undergraduate to graduate programs. *Journal of Diversity in Higher Education, 4*(2), 90-105. doi:10.1037/a0021679

Osborne, J., Simon, S., & Collins, S. (2003) Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049-1079.

Osborne, J., Simon, S., & Tytler, R. (2009, April). *Attitudes Towards Science: An Update*. Presentation at the Annual Meeting of the American Educational Research Association. San Diego, California.

Petre, M., & Price, B. (2004). Using Robotics to Motivate "Back Door" Learning. *Education and Information Technologies, 9*(2), 147-158.

Potvin, P., & Hasni, A. J. (2014). Analysis of the Decline in Interest Towards School Science and Technology from Grades 5 Through 11. *Journal of Science Education and Technology, 23*(6), 784-802. doi:10.1007/s10956-014-9512-x

Reić-Ercegovac, I. R., & Jukić, T. (2008). Cooperative Learning in Class Teaching. *Life and school: journal for the theory and practice of education, 20*(2), 69-80.

Ritchie, J., & Spencer, L. (1994). Qualitative data analysis for applied policy research. In A. Bryman & R. G. Burgess (Eds.), *Analyzing qualitative data* (pp. 173-194). UK: Taylor & Francis books.

Rosenzweig, E. Q., & Wigfield, A. (2016). STEM motivation interventions for adolescent: A promising start, but further to go. *Educational Psychologist, 51*(2), 146-163. doi:10.1080/00461520.2016.1154792

Sklar, E., Eguchi, A., & Johnson, J. (2003). RoboCupJunior: Learning with Educational Robotics. In G. A. Kaminka, P. U. Lima & R. Rojas (Eds.), *RoboCup 2002, LNAI, 2752* (pp. 238-253). Berlin Heidelberg: Springer-Verlag.

Scott-Little, C., Hamann, M. S., & Jurs, S. G. (2002). Evaluations of After-School Programs: A Meta-Evaluation of Methodologies and Narrative Synthesis of Findings. *American Journal of Evaluation*, *23*(4), 387-419.

Shoffner, M. F., & Dockery, D. J. (2015). Promoting interest in and entry into Science, Technology, Engineering, And Mathematics Careers. In P. J. Hartung, M. L. Savickas & W. B. Walsh (Eds.), *APA handbook of career intervention, Volume 2: Applications,* (pp. 125–137). Washington, DC: American Psychological Association. doi:10.1037/14439-010

Srivastava, A., & Thomson, S. B. (2009). Framework Analysis: A qualitative Methodology for Applied Policy Research. *JOAAG, 4*(2), 72-79.

Su R., Rounds J., & Armstrong P. I. (2009). Men and things, women and people: A meta-analysis of sex differences in interests. *Psychological Bulletin, 135,* 859–884.

Valla, J. M., & Williams, W. M. (2012). Increasing achievement and higher-education Representation of under-represented groups in Science, technology, engineering, and mathematics Fields: a review of current k-12 intervention Programs. *J Women Minor Sci Eng., 18*(1), 21-53.

Wentzel, K. R., & Wigfield, A. (2007). Motivational interventions that work: Themes and remaining issues. *Educational Psychologist*, *42*(4), 261-271. doi:10.1080/00461520701621103

Wigfield, A., & Eccles, J. S. (1992). The development of achievement task values: A theoretical analysis. *Developmental Review, 12*, 265-310.

Wigfield, A., Eccles, J. S., Yoon, K. S., Harold, R. D., Arbreton, A., Freedman-Doan, C., & Blumenfeld, P. C. (1997). Changes in children's competence beliefs and subjective task values across the elementary school years: A three-year study. *Journal of Educational Psychology, 89,* 451-469.