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# Empirical Analysis of Factors Preventing Pupils from Choosing STEM Fields

## Veiksnių, turinčių įtakos STEAM dalykų pasirinkimui, empirinė analizė

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**Summary.** As technological developments expand globally, the need for science, technology, engineering, and math (STEAM)-relate d professions has grown. Emphasis on STEAM-oriented careers and study choices has expanded in many educational systems in the world. The research focuses on students‘ attitudes towards STEM subjects inside and outside of school, their motivation to study and pursue a STEM career. Key results indicate that students have reservations in pursuing a STEAM career and that their academic and practical motivation to study STEAM varies. The study suggests that employing a diverse, practical approach towards teaching STEAM subjects could encourage more students to choose STEAM subjects and careers. Research object is to explore the factors associated with the low number of students choosing to study and pursue careers in STEM (Science, Technology, Engineering, Mathematics) fields after secondary education in Lithuania. Aim of research is to understand the factors influencing the choices of young people in Lithuania regarding STEM subjects and careers. Objectives: 1. To identify and analyse the factors that prevent students from choosing STEM fields; 2. To explore the differences in attitudes and motivations towards STEM between male and female students. Method of research: Conducting a quantitative analysis through online surveys involving 196 high school students from Šiauliai, Lithuania.

Keywords: STEAM, education, Lithuania, high school studies, career choice.

## Introduction

This research study will explore factors associated with the low number of students who focus on study and career paths in the field of STEM after secondary education. Steam education is an important subject of many scientific studies (Bøjer B., 2021, Jain, G., 2020, Lee, 2018). As Darlington (2017) notes “student interest and engagement with particular subjects will wax and wane throughout their school careers as the nature and relative importance of the influencing factors vary”. In Lithuania, conditions are created for students to conduct experimental research, construct, model, become familiar

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with scientific innovations, etc., during or after lessons. This focuses on learning based on competencies and experiential learning (Levine, Patrick, 2019, Palmer, et al., 2017, Khurma, et al., 2022).

This is being done in the face of a lack of research studies on the reasons for low interest in the STEM field and drop-in rates after secondary education (Al-Emran, Al-Sharafi, 2022), as well as the differences from country to country. This complex problem is relevant both at the national and EU levels (LAMA BPO, 2023; Committee on Strategy, 2020). Paviotti (2020) notes that "the STEM field is associated with low unemployment rates and good economic prospects. However, despite the auspicious prospects, many countries face the problem of an inadequate supply of STEM graduates".

With the increasing demand for STEM specialists in various industries, it is important to understand how to encourage more students to choose a STEM career (López et al., 2023).

The empirical study focuses on the perception of students from 9th to 11th grade. This target group was chosen due to the nature of this particular timeline in their studies since this time is when they must choose their further study path or have just recently made the choice. The empirical study will present the results of quantitative research aiming to outline the reasons from a cohort of students in Šiauliai (Lithuania) regarding their choices of subjects for their future careers. It will investigate what are their learning habits and attitudes towards different subjects. The main descriptive data factor will be gender, comparing how boys and girls have different attitudes and approaches to learning STEM.

The following chapter summarizes empirical data collected by carrying out an online survey involving 196 student participants from high schools in Lithuania. The chapter aims to perform an analysis that reveals the major reasons and barriers for choosing a STEM study path in higher education and career choice. The data was collected using an online survey via Google Forms and involved a set of 19 questions. The data analysis is used for concluding STEM learning habits, knowledge attainment, and reasons for choosing both subjects in this field as well as considering a career path towards STEM careers – sciences, mathematics, IT, engineering.

## Demographics

Out of 196 participants, 126 (64,6%) participants were female and 69 (35,4%) were male. Even though the optimal number could be closer to 50/50 for equal gender representation this number should not affect the quality of the study. In addition, this division of respondents enabled the researcher to draw comparisons between genders which is important in addressing key issues regarding the choice differences and reasons for choosing STEM fields between women and men.

The majority of participants involved in the study were from the 9th grade (87,7%), with the next largest groups from 10th and 11th grade and consisted of 4,6% and 6,2%. This composition of participants enabled the research to focus more on the prevailing reasons for choosing STEM fields early on because during the 9-11th grades the students tend to shift towards either humanities/arts or STEM fields.

## School and parental support

This section summarizes an analysis of how teachers and parents encourage and support students to pursue a STEAM field. Both educators' support and parents' support is of key importance in pursuing a STEM field and developing a natural interest in the field.

The first question from the support bracket was concerned with overall parents' support for the STEM fields and asked if parents encourage students to learn science, IT, and/or math in school. More than half (52,8%) of respondents indicated that their parents encourage them to learn STEM subjects and only 22,65 indicated that they are not encouraged. Here we observe an interesting dissimilarity between respondents as girls tended to be encouraged more often than boys. Only 34,8% of boys agreed to the statement in contrast to 54% of girls, we also observed a 20% disparity in disagreeing with the statement in favour of girls. This finding contradicts the popular stereotype that girls are discouraged to strive for STEM fields by their parents. This could also indicate a shift in the younger generation's parents' attitudes towards girls entering engineering, IT, or other science-related disciplines as career choices.

The second question asked the participants if the Science teachers encouraged me to go on and major in high school science.

Even though the majority of respondents indicated that they either disagreed or had no opinion regarding the question (46,2% disagreed), a quarter (25,4%) of them indicated that get support from their teachers. An interesting tendency is observed when analyzing gender-specific differences where we see that girls tend to be encouraged more than boys, 20,6% and 15%. This might be due to the overall discourse and guidelines for teachers on encouraging girl participation in STEM fields.

The final question regarded parents' support and asked the participants if their parents encouraged them to participate in out-of-school science, technology, and math programs (camps, clubs, modules). Overall, the participants do not tend to be encouraged by their parents to pursue STEM activities outside of the school curriculum. The results indicated that 57,4% are not encouraged by their parents for extracurricular activities and only 23,5% indicated that their parents wished them to engage in it. The biggest meaningful difference in this segment between boys and girls was that girls tended to disagree more with the statement than boys with 47,8% and 36,2%. This could mean that the parents might be more interested in girls' academic performance rather than practical skill application. Thus, participation in STEM-related extracurricular activities such as IT clubs, young technician activities, hackathons is secondary.

## Innate interest in the field of STEM

This section of the empirical research was concerned with an interest in the field of STEM inside and outside of the school curriculum. It investigates how the participants engaged in STEM fields, what their level of expertise was and a natural interest in different subjects were. It also focused on their independent engagement in STEM subjects in their free time and how that correlates with their self-perception of their expertise.

Firstly, we would like to analyse how the participants engage in STEM subjects in their free time. This will allow us to investigate how the respondents invest their time in the skillset development as well as give us a picture of what their innate interest in the field looks like.

The results indicate the division of responses to the question of whether the participants like to disassemble various machines, such as computers, telephones, etc. The division here was almost identical with 47% of respondents agreeing and 37% disagreeing with the statement. However, the biggest disparity between boys and girls was that girls tended to disagree with the statement more with the difference of 10 percentage points. This notion presupposes that both boys and girls have a natural curiosity towards engineering and how things work. However, one can observe the tendency that the practical side of STEM fields discourages girls and they lack the motivation to engage in this type of practical skill attainment.

Results also point to how respondents engage in STEM subjects at home in their leisure time. The main subjects for this were science, math, and programming. Overall, 31,8% of respondents indicated that they like doing science at home in their leisure time, as opposed to the 39,1% who do not. Girls tended to enjoy doing science at home rather than boys (accordingly 34,7% and 24,6%). In addition, boys tended to disagree more than girls with 46,3% to 40,5% respectively, disagreeing with the statement. These responses could be directly linked with the factors that girls are more encouraged by their parents to engage in STEM subjects, which creates a more motivational learning environment at home. Moreover, this could also be directly linked with the fact that girls tended to focus more on academic achievement, rather than "the fun of it".

When asked if the participants enjoy doing programming at home the respondents indicated that they mostly disagree with this statement. An overwhelming 57,7% indicated that they do not like engaging in this activity as well as only 20% said that they enjoy it. This finding is rather surprising, given that the IT sector is booming now all over the world, Lithuania also being the case.

Here we observe one of the biggest disparities in the study between girls and boys. The data revealed that 39,1% of boys enjoy doing programming at home and only 9,5% of girls do so with 68,2% saying that they indeed do not. This could be a direct indicator that there still exist certain prevalent stereotypes even among the STEM fields and that girls need more incentive to engage in IT subjects.

When it came to doing mathematics at home, the respondents indicated that they do not particularly enjoy that subject. In total, 54,8% of respondents indicated that they do not enjoy doing extracurricular activities in maths and only 24,6% agreed. In addition, we do not see any statistically relevant differences between boys and girls in this section.

In this chapter, one can observe how the respondents showed their innate interest in the STEM subjects and in which disciplines they were voluntary to invest their free time. We observed an ongoing tendency that the girls were more prone to academic achievement attainment rather than practical skill development. This is explained by their willingness to engage with science and math subjects in their free time, however, they have a little

less interest in practical skill application subjects such as programming and engineering. The data also indicated that there might be a link between a more motivational learning environment in households of girls rather than boys.

## STEM field competence

This section of the empirical research was concerned with the respondents' competence in STEM subjects. We analysed how the participants evaluate their own ability to learn and use STEM subjects, how they assess their academic performance, and their ability to study the field.

The participants were asked if they have problems understanding scientific theories and laws (e.g. Newton law). One-third of respondents (34,3%) indicated that they do not have any issues learning new scientific theories. However, if we analyze the data based on gender, we see that boys think they have a better grasp on scientific theories than girls, with correspondingly 42% to 31% of who agreed to the statement. This provides us with an interesting ambiguity that even though the data so far indicated that the girls are more prone to academic achievements, boys tend to have more confidence in their knowledge.

The next question was concerned with participants' academic performance and asked if they have any problems with getting a good grade in their mathematics, IT, or sciences (Physics, Biology, Chemistry) classes. Here we do not observe any relevant statistical differences between boys and girls and see a healthy attitude towards their academic performance evaluation. In total, 47,7% of respondents indicated that they are confident in their STEM grade attainments, whereas 23,1% were not. However, if we incorporate the data from section "Neither agree nor disagree" we see that 53,3% of respondents are not sure about their academic performance in STEM subjects.

The research explored how the students were interested in tasks related to engineering and construction. The data indicated that 34,4% of respondents enjoyed these types of tasks. However, we saw a slight difference between boys and girls where girls tended to disagree more strongly with the statement with 16%, opposed to only 4% of boys.

## Career in the STEM field

This section aimed to identify how the respondents see themselves in the path of choosing a STEM field career and how they model their behaviours and academic goals toward attaining that goal. The questions included both the academic performance and their desire to work in the STEM field, as well as knowledge of what constitutes the field. When asked if they are aware of any STEM field professionals, only 22,5% of respondents agreed that they can. There were no differences between boys and girls in this area.

The participants were asked if STEM fields are important to them and if they regard these subjects highly. The majority of respondents (50,8%) agreed that STEM fields are important to them, whereas only 20% of them disagreed with the statement. Both girls and boys tended to agree quite similarly.

The majority of the participants (53,7%) agreed that if they do well in STEM subjects it would aid them in their careers in the future. Almost none of the male participants strongly disagreed with the statement, whereas 10% of girls indicated that they would not benefit from that. The overall ratio of opinions tended to shift more towards boys agreeing to this statement with the gap of over 20%.

One-third of the participants (37,9%) agreed that they were interested in careers that involved the use of technology. However, here we observe a great disparity between boys and girls with only 26,9% of the girls agreeing and 34,4% disagreeing with the statement. Whereas only 18,4% of boys tended to disagree with the statement.

The respondents tended to agree (59,5%) overall that if they studied STEM subjects they would have more opportunities for a greater variety of career choices in the future. There were no substantial differences between boys and girls in this part.

Overall 64,2% of respondents agreed that learning STEAM subjects is the way to open a variety of career choices. Acknowledging that learning STEAM subjects might help a lot in their future careers is highly important. We live in an ever-changing technological world and the respondents seem to have a good grasp of how the world will look like when they are in the workforce regardless of their career choices.

## Discussion

The need for STEM-related vocations has increased as we move towards a more technological economy. The 4th and upcoming 5th industrial revolutions will demand a labour market with competencies in these fields. The data and strategic planning from the European Union, the US, and other international trade, social and educational organizations indicate that the world is already facing a STEM specialist shortage.

The research shows that girls tend to be more encouraged by their parents and teachers to both pursue academic and extracurricular activities in STEM, whereas boys tended to be encouraged less. This finding contradicts the popular stereotype that girls are discouraged to strive for STEM fields by their parents. This might point to the fact that gender balance ensuring/encouraging processes are working at this level of education. It was observed that the respondents are being sufficiently encouraged by both their parents and teachers to engage more actively in STEM subjects. This could be the result of the overall national education agenda and the push for STEM education, especially in the case of teacher encouragement. A key positive take of the analysis is how girls are either equally or more actively encouraged by teachers and parents. However, the data indicates that parents are more interested in the academic performance of STEM subjects, rather than practical skill development and application.

Students were only partially encouraged by their parents for extracurricular activities and the data showed that parents might be more interested in girls' academic performance rather than practical skill application. Thus, participation in extracurricular activities such as IT clubs, young technician activities, and hackathons is of secondary interest. However, the literature (STEM Alliance, EU STEM Coalition) suggests that practical skills

development might be an effective way to encourage mutual interest in the field among students and shift away from overly academic methods of training. Thus, this suggests the need to encourage more participation in extracurricular activities that provide more hands-on learning opportunities.

The survey responses showed that both boys and girls have a natural curiosity towards engineering and how things work. However, responses suggest that girls are less encouraged to engage in hands-on activities and more actively engaged in academic extracurricular activities and associated with STEM. This provides us with an interesting ambiguity that even though the data so far indicates that girls are reaching high academic achievements, boys tend to have more confidence in their knowledge.

Another key finding was that girls were not particularly interested in programming. This finding could show certain negative trends for future career development of female IT specialists, even though such a career choice could be viable for anyone, regardless of gender. The data showed that boys tend to be much more interested in the IT sector both in terms of academic achievements and extracurricular activities. We observed a tendency that the female respondents were more focused on academic achievement attainment rather than practical skill development. This is explained by their willingness to engage with science and math subjects in their free time, however, they have a little less interest in practical skill application subjects such as programming and engineering.

## Conclusions

The overall tendency of respondents pointed to a favourable view of STEM careers. However, responses from boys tended to point to the continued existence of a stereotypical pull for boys towards the STEM sectors. Even though the literature suggests that a more practical learning approach might be more suitable and motivating for students. The data in the survey suggests that the students, especially girls, tend to see the STEM fields more as an academic, achievement driven agenda, while boys tend to have a more holistic interest in STEM fields. However, we observe that respondents understand that a STEM career is stable and rewarding in the long run. Ultimately, the expansion of hybrid learning and teaching strategies are seen as a key pathway to fulfilling the demand of STEM specialists in the future (Jain, 2020).

## References

Al-Emran, M., A., & Al-Sharafi, M. (2022). Revolutionizing Education with Industry 5.0: Challenges and Future Research Agendas. *International Journal of Information Technology and Language Studies*, 6(3), 1-5.

Bøjer B. (2021). Creating a Space for Innovative Learning: The Importance of Engaging the Users in the Design Process. In: Imms W., Kvan T. (eds) *Teacher Transition into Innovative Learning Environments*. Springer, Singapore. https://doi.org/10.1007/978-981-15-7497-9_4

Committee on Strategy (2020). *STEM Education of the Future - A Visioning Report*. https://www.nsf.gov/ehr/Materials/STEM%20Education%20for%20the%20Future%20-%202020%20Visioning%20Report.pdf

Darlington H. M. (2017). Understanding and developing student interest in science: an investigation of 14-16-year-old students in England. Doctoral thesis (Ph.D.), UCL (University College London).

*The Future of Jobs Report* (2023). World Economic forum. https://www.weforum.org/publications/the-future-of-jobs-report-2023/

Jain, G. (2020). Emerging Trends of Education During & Post COVID 19: A New Challenge. *Solid State Technology*, 63(1), 796-806.

Khurma, O.A., Al Darayseh, A., & Al Ramamneh, Y. (2022). A Framework for Incorporating the "Learning How to Learn" Approach in Teaching STEM Education. Education Sciences, 13(1), 1-12.

LAMA BPO (2023). *Centralizuoto priėmimo į Lietuvos aukštąsias mokyklas apžvalga.* https://lamabpo.lt/apzvalgos-2023m/

Lee, M., Yun, J., Pyka, A., Won, D., Kodama, F., Schiuma, G., & Zhao, X. (2018). How to Respond to the Fourth Industrial Revolution, or the Second Information Technology Revolution? Dynamic New Combinations between Technology, Market, and Society through Open Innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 4(3), 21. https://www.mdpi.com/2199-8531/4/3/21#

Levine, E., & Patrick, S. (2019). *What is competency-based education? An updated definition.* Vienna, VA: Aurora Institute.

López, P., Simó, P., & Marco, J. (2¬023). *Understanding STEM career choices: A systematic mapping. Heliyon*. https://doi.org/10.1016/j.heliyon.2023.e16676

Palmer, T. A., Burke, P., & Aubusson, P. (2017). Why school students choose and reject science: a study of the factors that students consider when selecting subjects. I*nternational Journal of Science Education*, 39, 1-18. 10.1080/09500693.2017.1299949.

Paviotti, G. (2020). The challenge of career education. *Education sciences and society*, 11(1). https://doi.org/10.3280/ess1-2020oa9576