# Initial view of the perception of STEM disciplines among students at school

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**Abstract**

The article presents the initial results of a study of the perception of STEM disciplines among middle and high school students at the private school "Innovative Lyceum "I-School". The authors highlighted the differences in the perception of STEM disciplines by category. The researchers found that the preliminary initial data indicate that it is necessary to improve STEM programs for each grade separately. In addition, the authors propose the idea of creating a diagnostic digital platform 'STEM. The School Diagnostic Tool'. In the future, this platform might be used to improve the planning strategies for studying STEM disciplines by teachers and school leaders.

**Keywords**

STEM disciplines, 'STEM. School Diagnostic Tool', interest in STEM, STEM education

## 1. Introduction

In connection with the achievements of the STEM field, the demand for qualified specialists is growing, which makes STEM education the basis of modern educational programs in the world. However, involving students in studying STEM disciplines remains a challenge for educators. Understanding students' perception of STEM disciplines and careers in these fields is necessary for the development of effective educational programs. Studies have shown that a positive attitude towards these subjects during school years significantly affects career aspirations [1]. For example, the involvement of girls in science was investigated by the authors in [2]. The relationship between interest in STEM and career intentions of high school students was investigated by Peterman et al. [3]. Measuring students' career interest in the context of technologically advanced STEM projects: a cross-project comparative study based on a career interest questionnaire is described by Peterman et al. [3]. Contrasting perceptions of STEM content and careers were investigated in [4]. Therefore, assessing how learners perceive STEM, whether it is perceived as exciting, meaningful or relevant, provides important insights for educators and program developers [5]. In order to investigate the interest, appeal, fascination, excitement, importance and meaning of STEM disciplines among the middle and high school students and their perception of STEM careers, the authors defined the following goal and research objectives.

Research goal: to study the perception of STEM subjects among students in grades 5-11 for a preliminary quantitative assessment of the differences between the perception of STEM subjects and a career in STEM and to propose the idea of creating a test program for the development plan for STEM subjects in an educational institution.

Research objectives: 1) conduct a survey among students in grades from 5th to 11th at the private educational institution "Innovative Lyceum "I-School" using the STEM Semantics Survey questionnaire; 2) distribute the results of the survey data by categories; 3) compare the perception of a career in STEM among students in grades 5th, 9th and 11th; 4) analyze modern digital tools to assist in planning STEM education in educational institutions; 5) propose the idea of creating a digital platform 'STEM. School

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diagnostic tool'. We believe that the results obtained will allow us to draw conclusions and identify how to improve interest in STEM education.

## 2. Methodology

The aim of our research is to analyze the perception of STEM disciplines among the students of secondary and high schools. The research has been conducted using the survey on STEM perception [6]. The questionnaire was translated into Ukrainian by the authors of the article and adapted. The survey was conducted among students in grades 5 and 11. The research indicates the preferences for studying STEM disciplines and careers by different age groups and grade classes in schools. The data used to evaluate the survey results included 75 people. The surveyed participants studied in grades 5-11 at the private school "Innovative Lyceum I-School". Among these participants included 42 girls ( 56 % ) and 33 boys ( 44 % ). The survey was conducted using the Likert Scale with 7 items. The average value is 4 on this scale.

In private school "Innovative Lyceum "I-School", students study full-time day (from 9:00 a.m. to 6:00 p.m.). In elementary school, students learn STEM as a subject once a week. In middle and high school, they have a STEM Day once a week for different classes. After basic lessons in the afternoon, students have classes and clubs to choose: robotics, IT technologies and other disciplines. The lyceum has been an individual educational trajectory for each student, so students additionally attend lessons in mathematics and natural sciences.

As STEM education is actively developing in the lyceum, the authors decided to investigate how the approach to teaching, learning and planning the STEM direction might be improved. Research and statistics are based just on private school "Innovative Lyceum "I-School".

It also needs to be clarified that the number of students participating in the survey is not enough to draw strong, statistically valid conclusions from the results. However, the results of the assessment might be used to recognize certain trends and to explore them in more detail in future assessments. The data obtained are based solely on participants' self-assessments and are not compared to large representative groups of students. Therefore, the possibility of overestimation and underestimation by students can't be ruled out.

## 3. Results

In this research, the following methods have been used to determine differences in perceptions of STEM disciplines: analysis of mean scores and ranking. To assess the differences between disciplines, the mean scores for each category have been compared. A comparison of the mean scores for each discipline for students in grades 5-11 by category (C1 – C5) shows in figures 1-4.

Analyzing the figures 1-4, initial data indicates that for the "Innovative Lyceum "I-School" students in grade 5 seem to be more interested in STEM subjects than students in grade 11. For example, the average score on the Likert scale is 4, and if the results of the survey of 11th grade students in 'Engineering', 'Mathematics' and 'Technology' disciplines are taken, they score below this average, indicating the importance of engaging and motivating students to study these disciplines. There is also a noticeable decline in interest in engineering among 8th grade students. In order to perform a more detailed analysis and to understand which subjects students are more interested in, the authors ranked the STEM subjects for each category according to the average score: the highest average score means greater interest and is given rank 1 (the most interesting), and as the average score decreases, the rank increases. The results are shown in table 1.

The results of the rankings for different categories C1 – C5 indicate some trends in the distribution of students' preferences. In order to understand more clearly the preferences for STEM studies among students in grades 5-11, this study suggests creating a sequence of STEM disciplines according to scoring. The analysis showed that 5th grade students are most excited, fascinated, and meaningful to learn 'Mathematics' and 'Engineering'. In grades 5-9, 'Technology' is most often ranked in the top place.

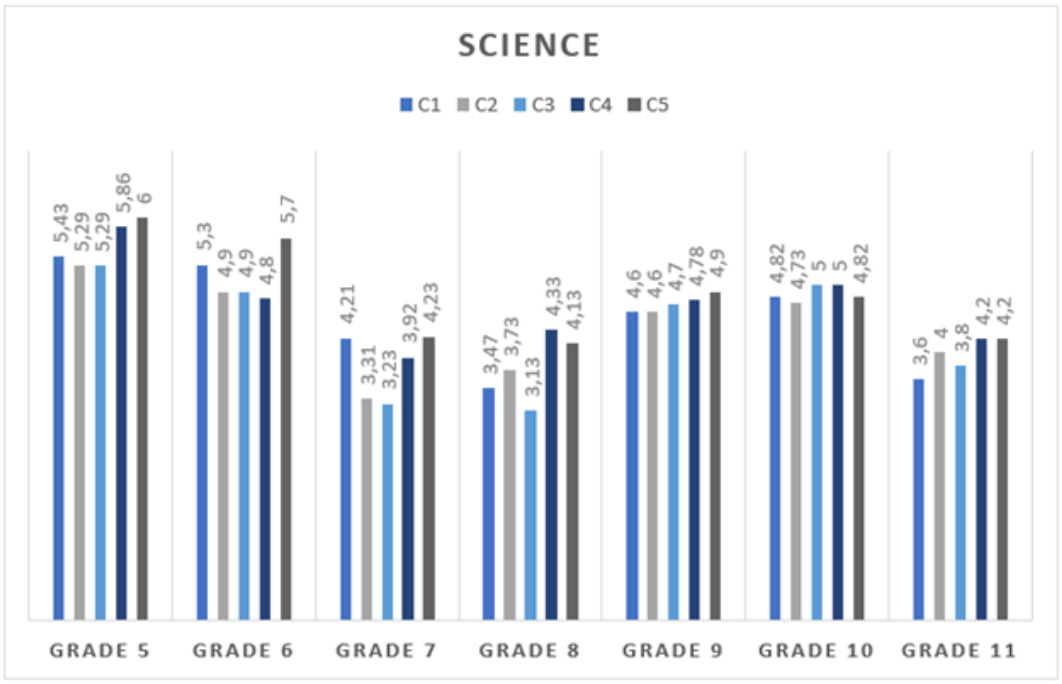


**Figure 1:** Comparison of the perception of STEM disciplines "SCIENCE". Abbreviations: C1 – fascinating/mundane; C2 – appealing/unappealing; C3 – exciting/unexciting; C4 – means a lot /means nothing; C5 -– interesting/boring.

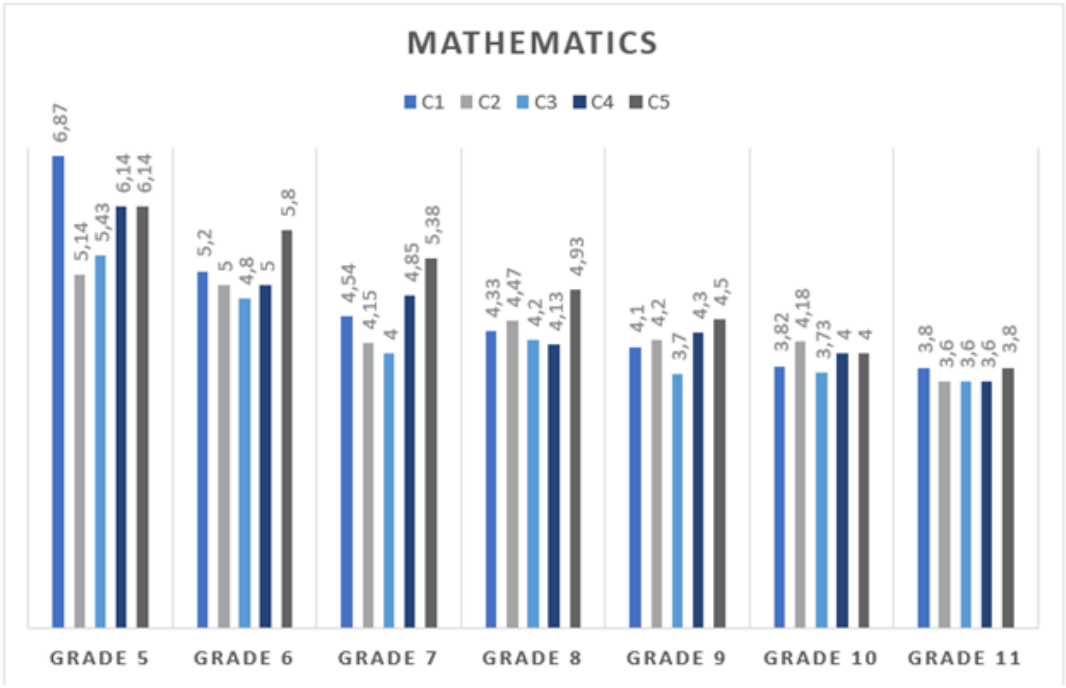


**Figure 2:** Comparison of the perception of STEM disciplines "MATHEMATICS". Abbreviations: C1 – fascinating/mundane; C2 – appealing/unappealing; C3 – exciting/unexciting; C4 – means a lot /means nothing; C5 – interesting/boring.

Students in the 10th grade prefer 'Science'. And for 11th grade students in the C2 – C5 categories, the sequence of disciplines does not change, which indicates a stable preference. Consider the results of the survey comparing the perception of STEM careers (figure 5).

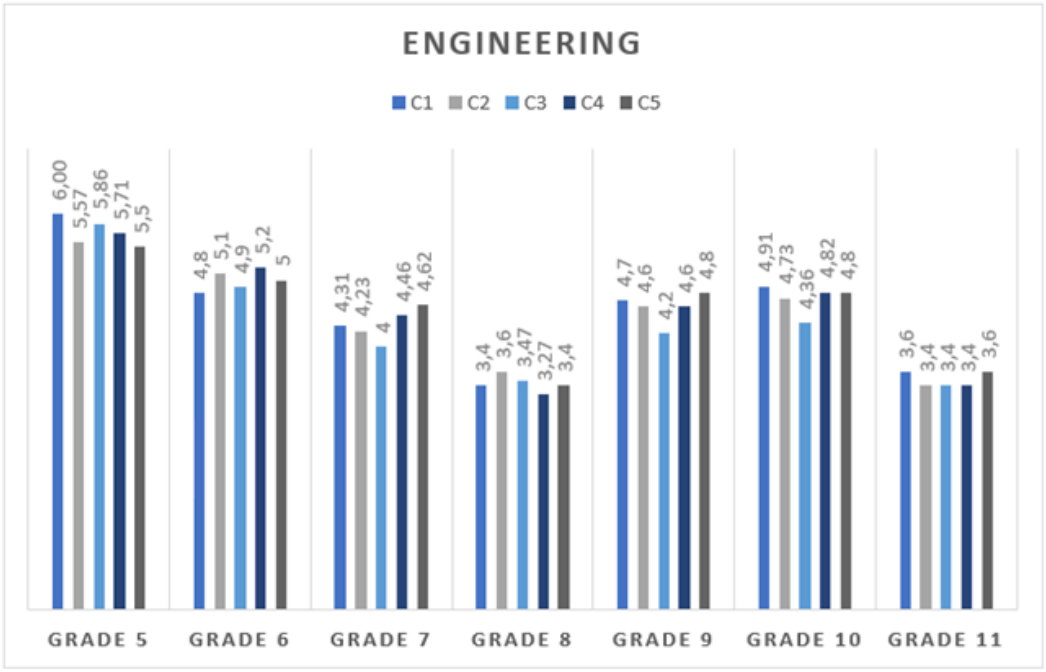


**Figure 3:** Comparison of the perception of STEM disciplines "ENGINEERING". Abbreviations: C1 – fascinating/mundane; C2 – appealing/unappealing; C3 – exciting/unexciting; C4 – means a lot /means nothing; C5 – interesting/boring.

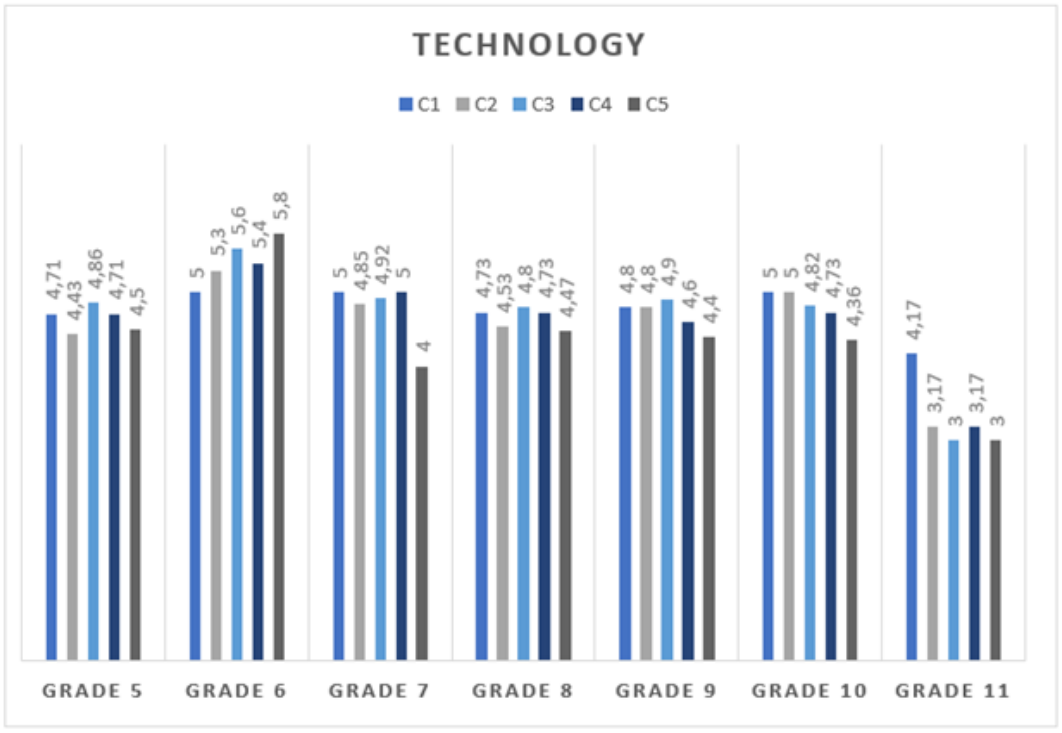


**Figure 4:** Comparison of the perception of STEM disciplines "TECHNOLOGY". Abbreviations: C1 – fascinating/mundane; C2 – appealing/unappealing; C3 – exciting/unexciting; C4 – means a lot /means nothing; C5 – interesting/boring.

In order to analyze the data (see figure 5), we used the results of responses from students in grades 5, 9 and 11. In grade 5, students are just beginning to study science subjects. Grade 9 students are

**Table 1**
Rank scores. STEM disciplines. Abbreviations: N – number of students; S – Science; M – Mathematics; E – Engineering; T – Technology; C1 – fascinating/mundane; C2 – appealing/unappealing; C3 – exciting/unexciting; C4 – means a lot /means nothing; C5 – interesting/boring.

| GRADE | N | S | M | E | T | Ranking of STEM disciplines |
|---|---|---|---|---|---|---|
| | | | C1 | | | |
| 5 | 8 | 4 | 1 | 3 | 2 | M-T-E-S |
| 6 | 10 | 1 | 2 | 4 | 3 | S-M-T-E |
| 7 | 13 | 4 | 2 | 3 | 1 | T-M-E-S |
| 8 | 15 | 3 | 2 | 4 | 1 | T-M-S-E |
| 9 | 8 | 3 | 4 | 2 | 1 | T-E-S-M |
| 10 | 16 | 3 | 4 | 2 | 1 | T-E-S-M |
| 11 | 5 | 3 | 2 | 4 | 1 | T-M-S-E |
| | | | C2 | | | |
| 5 | 8 | 2 | 4 | 1 | 3 | E-S-T-M |
| 6 | 10 | 4 | 3 | 2 | 1 | T-E-M-S |
| 7 | 13 | 4 | 3 | 2 | 1 | T-E-M-S |
| 8 | 15 | 4 | 2 | 3 | 1 | T-M-E-S |
| 9 | 8 | 3 | 4 | 2 | 1 | T-E-S-M |
| 10 | 16 | 3 | 4 | 2 | 1 | T-E-S-M |
| 11 | 5 | 1 | 2 | 3 | 4 | S-M-E-T |
| | | | C3 | | | |
| 5 | 8 | 3 | 2 | 1 | 4 | E-M-S-T |
| 6 | 10 | 3 | 4 | 2 | 1 | T-E-S-M |
| 7 | 13 | 4 | 1 | 2 | 3 | M-E-T-S |
| 8 | 15 | 4 | 2 | 3 | 1 | T-M-E-S |
| 9 | 8 | 2 | 4 | 3 | 1 | T-S-M-E |
| 10 | 16 | 1 | 4 | 3 | 2 | S-T-E-M |
| 11 | 5 | 1 | 2 | 3 | 4 | S-M-E-T |
| | | | C4 | | | |
| 5 | 8 | 2 | 1 | 3 | 4 | M-S-E-T |
| 6 | 10 | 4 | 3 | 2 | 1 | T-E-M-S |
| 7 | 13 | 4 | 2 | 3 | 1 | T-M-E-S |
| 8 | 15 | 2 | 3 | 4 | 1 | T-S-M-E |
| 9 | 8 | 1 | 4 | 3 | 2 | S-T-E-M |
| 10 | 16 | 1 | 4 | 2 | 3 | S-E-T-M |
| 11 | 5 | 1 | 2 | 3 | 4 | S-M-E-T |
| | | | C5 | | | |
| 5 | 8 | 2 | 1 | 3 | 4 | M-S-E-T |
| 6 | 10 | 3 | 1 | 4 | 2 | M-T-S-E |
| 7 | 13 | 3 | 2 | 1 | 4 | E-M-S-T |
| 8 | 15 | 3 | 1 | 4 | 2 | M-T-S-E |
| 9 | 8 | 1 | 3 | 2 | 4 | S-E-M-T |
| 10 | 16 | 1 | 3 | 2 | 4 | S-E-M-T |
| 11 | 5 | 1 | 2 | 3 | 4 | S-M-E-T |

finishing secondary school, so the result of the survey on students' preferences is quite interesting. And the results of the survey of grade 11 students show an interest in STEM careers after high school. Figure 5 shows that STEM careers are important for 5th graders in all categories, but these values decrease for 9th, and 11th graders. Moreover, for 11th graders, the lowest scores were obtained in categories C2-C5, but the respondents noted that a career in STEM is fascinating (C1). Therefore, it can be concluded from the results of the survey in this research that there is a need to improve educational programs for each grades in school separately. The importance of developing innovative approaches to increase interest in STEM subjects remains one of the key challenges for students between grades 5 and 11. It should be noted that different age groups of students have different preferences for STEM subjects. Thus, in

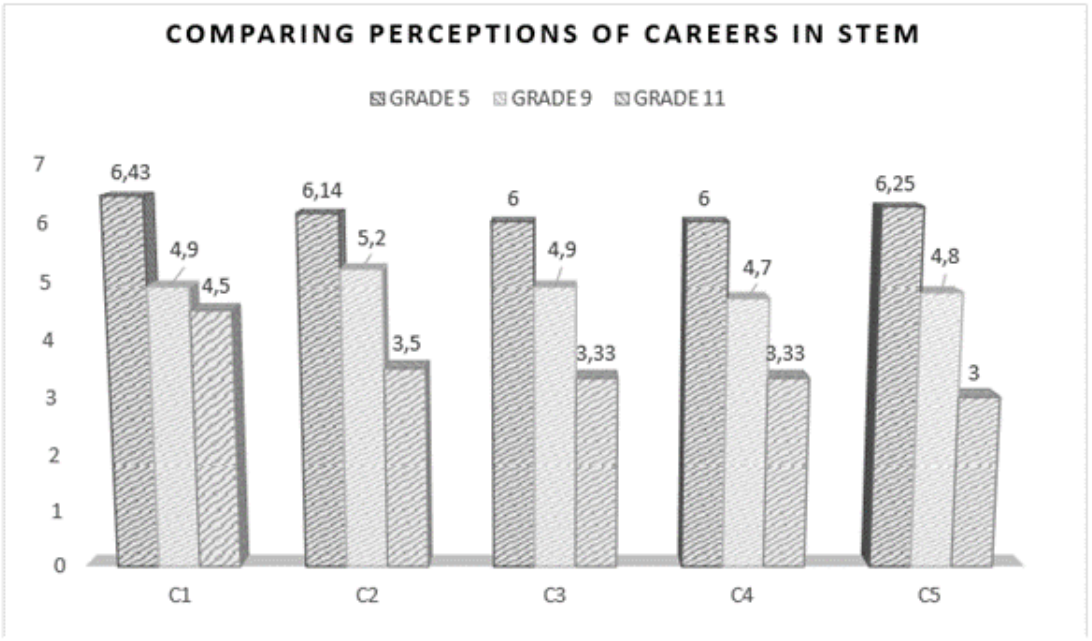


**Figure 5:** Comparing perceptions of careers in STEM. Abbreviations: C1 – fascinating/mundane; C2 – appealing/unappealing; C3 – exciting/unexciting; C4 – means a lot /means nothing; C5 – interesting/boring.

order to implement the idea of improving STEM education programs, it would be advisable to offer a software solution that, based on the results of the questionnaire, could automatically provide schools with recommendations to support interest in STEM subjects in the classroom, but should not overload the learning process. Nowadays, there are software solutions and digital applications for analyzing the level of interest in STEM subjects. Achieve3000 [7], for example, provides personalized learning adapted to the student's level and allows for progress tracking. The MyCareerMatch platform [8] is easy to use, has a user-friendly interface and is focused on student career guidance; it offers interactive recommendations for teachers on developing career skills. Also, for such a research, it is possible to use the CareerExplorer [9], Qualtrics [10], Naviance [11] and other platforms. Reviewing these platforms, it is clear that the high functionality and recommendations in STEM for teachers have a significant impact on curriculum development and amendments to the learning process. In the authors' opinion, it would be advisable to develop a test program "STEM. School Diagnostic Tool" for teachers and school administrators to identify the level of students' interest in STEM disciplines and STEM careers. This tool would be easy to use for both teachers and school supervisors to plan additional activities or materials for lessons according to the age group of students, both during lessons and in extracurricular activities; and assist the school supervisor in formulating a plan for the development of STEM disciplines in the school.

## 4. Discussions

In the next study, the authors also plan to conduct further research and, based on the data obtained (quantitative and qualitative analysis). A deeper analysis of future research, the authors plan to conduct a survey in the form of interviews or focus groups, which can provide a qualitative analysis of the questionnaire and compare it with the quantitative analysis. In the future, the results of a survey of students from other schools will also be interesting.

After a deeper analysis, this research might be the next step to plan to design and test the results of the developed program "STEM. School Diagnostic Tool" to test the results of the recommendations for

different age groups of students studying in different grades for teachers and school leaders.

## 5. Conclusions

The study divided the survey results into categories from C1 to C5, which helped to analyze the data in more detail. According to the results of the survey of students' perception of STEM disciplines, it should be noted that the above average score was obtained in the discipline 'Science' in the 5th, 6th, 9th, 10th and 11th grades; in the discipline 'Mathematic' in grades from 5th to 9th; in the discipline 'Engineering' in grades 5th, 6th, 7th, 9th and 10th; in the 'Technology' discipline from grades 5th to 10th.

Regarding the comparison of the perception of a career in STEM among students in grades 5th, 9th, and 11th, it should be noted that students in grades 5 have been the most interested, and pupils in grades 11 were the least. As a result of this survey, it is possible to offer each school to make proposals for the implementation of STEM education. The authors conducted a study to compare the perception of STEM disciplines and careers. The survey results show some trends in the preferences of students. Notably, the results between different age groups are significant, but not significantly different in rank between different grades in the same parallel of 5th grades, which suggests that it is possible to provide recommendations for teachers and school administrators for one year of study. For example, separate recommendations from 5th to 11th grades. These results indicate a difference in responses in different grades, which was confirmed by the research.

Although STEM disciplines have the potential for further development among young people, they require improved teaching approaches, so it is proposed to develop the program "STEM. School Diagnostic Tool" to identify the level of students' interest in STEM disciplines and STEM careers. Significant differences that will be shown by the test results in this program may indicate that the perception of STEM disciplines depends on the age, level of study or experience of students. Changes in curricula and teaching approaches to STEM subjects may be necessary for different age groups to support and improve students' interest in these fields. The expected contribution of this paper is to provide important information about the perception of STEM disciplines by school students and the possibility of improving curricula and teaching approaches by: identifying differences in the perception of STEM disciplines among students in different grades and identifying similarities in the results of the same grade; analyzing attitudes toward STEM career opportunities among students in the 5th, 9th, and 11th grades.

## Author Contributions

Conceptualization – Yaroslav Sapsai; methodology – Yaroslav Sapsai; formulation of tasks analysis – Roman Chemerisskyi and Yaroslav Sapsai; software – Roman Chemerisskyi and Yaroslav Sapsai; writing – original draft – Roman Chemerisskyi and Iryna Sapsai; analysis of results – Yaroslav Sapsai and Roman Chemerisskyi; visualization – Yaroslav Sapsai and Iryna Sapsai; reviewing and editing – Iryna Sapsai and Yaroslav Sapsai. All authors have read and agreed to the published version of the manuscript.

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## Data Availability Statement

No new data were created or analysed during this study. Data sharing is not applicable.

## Conflicts of Interest

The authors declare no conflict of interest.

## Declaration on Generative AI

The authors have not employed any Generative AI tools.

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