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Searching for Pedagogical Answers to Support STEM Learning: Gender Perspective

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Abstract: This article analyzes the results of a study on the situation concerning the educational achievements of girls and boys in the STEM field in Latvia. The study was conducted at the compulsory education level to understand the conditions in the learning environment that can predictably affect the academic achievements of girls. For the purposes of the study, a survey questionnaire was developed, which was filled out by 1847 students from the 7th–12th grades. The obtained results show which factors affect learning achievement in STEM subjects for students with low and high learning achievements in groups divided into boys and girls and which pedagogical activities can predictably improve STEM learning achievements. The research data confirm that there are differences in predicted learning achievements in groups of boys and girls with high learning achievements, depending on the pedagogical strategy used. Additionally, the results of the study confirm that the most significant factor for a predictable increase in learning achievements in the STEM field is students liking mathematics and, in the case of high learning achievements, them liking chemistry. An indicator that has a significant negative impact on academic achievement in STEM subjects is a dislike of physics, which appeared in the group of girls with low academic achievements. Liking other STEM subjects to improve student achievement did not appear statistically significant in any of the analyzed groups. This study is essential to supplement the knowledge base on gender differences in learning achievements in STEM subjects and is also important for the educational space of Latvia because the learning achievements of girls in the STEM field are lower in this country than it is for boys. The obtained results show which methods of pedagogical work have a higher impact on increasing the predicted learning achievements and also show potential future research directions.

Keywords: gender differences; STEM; learning outcomes; compulsory education; pedagogical methods

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1. Introduction

It is known that there are relatively few women in the field of STEM (Science, Technology, Engineering, and Mathematics) [1–3] and that girls generally have lower academic achievement in STEM subjects [4,5]. There are many studies in which researchers have tried to find answers that explain the fact that girls both have lower academic achievement in the the STEM field and are still not choosing to study it in depth. Some studies have found evidence that stereotypes play a big role [6]. As a result, girls develop a negative attitude toward mathematics and other STEM subjects and this attitude, in turn, affects girls' academic achievements and whether they will choose to learn in-depth knowledge related to this field. This attitude is formed under the influence of teachers and parents [7] because they are three times more likely to associate STEM sciences with boys than with girls and these beliefs are internalized by the children they are with on a daily basis [8]. The majority of girls have to face gender discrimination in one of its forms as early as

their teenage years and, while this is most often from their peers, it is often also from adults with whom the children are together with on a daily basis—teachers, school staff, and even parents [7,9]. This experience can be of different levels of intensity, including when experiencing a stereotypical attitude, when faced with seemingly innocent comments about their appearance, and they can be offensive gestures or involve ignoring the female's expressed opinion.

2. Literature Review

Gender stereotypes have been found to affect girls who are considered gifted in STEM fields [10] because stereotypes in society can influence their choices and girls who do well in STEM have been found to choose a career in the humanities, life sciences, or social sciences instead of computer science, engineering, mathematics, or physics [6,11]. This is linked to regular expressions of microaggressions, which contribute to the fact that not everyone has equal access to STEM knowledge and contributes to the perception among girls that the STEM field is not for them [12,13]. The term "microaggression" was coined by Pierce (1970) [14] and, since then, there have been countless studies showing that it has a significant impact on underrepresented groups, which in the context of this study are girls in the STEM field. Both microassaults and microinsults accumulate and, over time, females begin to feel less capable in engineering because they feel marginalized, ignored, or even prevented from working on more serious projects in the STEM field [15]. The impact of microaggression on girls' choices is surprisingly high and it has been shown that girls exposed to microaggressions (compared to a control group) indicated a significantly lower desire to choose a career related to STEM [16,17].

Kessels (2005) [18] and Hannover and Kessels (2004) [19] concluded in their research that girls who like and are good at physics are considered more masculine and that the girls themselves perceived themselves as unpopular among boys. The boys' answers to the questions asked by the researchers also showed that they do not like girls who are interested in physics. Another study concluded that girls lose interest in STEM at the age of 10–15 [20]. The results of these studies may be one of the explanations why the break in girls' interest in the STEM field occurs precisely in adolescence, that is, when children begin to feel a romantic attraction toward each other, but there is no exact answer to the question of how to maintain this interest using pedagogical methods in the daily learning process.

Girls who believe that STEM is a subject for girls are better able to resist the discrimination and stereotyping they experience and this does not affect their motivation to study [21]. It is important to understand how to promote the development of motivation because it has been found that those students who have already developed a negative attitude toward STEM and who are indifferent to their learning achievements are no longer affected by various stereotypes [22]; these findings point to the importance of being purposeful in order to maintain this motivation toward STEM.

There are researchers who believe that apart from the influence of parents and educators, the surrounding environment is also important. For example, females who are in minority conditions showed a deficit in accuracy vis à vis females who were placed in same-sex conditions [23]. Additionally, setting the environment so that there are many references to the role of women, which can be expressed in the choice of learning materials or the colors of learning spaces and materials, can affect the learning achievements of girls [7,24]. One study experimentally demonstrated both that the pre-test information girls receive can lower their performance on that particular test and even that telling girls before the test that girls tend to perform lower academically on these types of tests can result in lower scores, but if such information is not provided before the test, then the results do not differ between boys and girls. This experiment also proved that negative self-esteem has an impact on academic achievement [22]. Similar conclusions were reached in another study, which found that boys and girls show equivalent learning results when their gender identity is not activated [25]. This evidence clearly shows that stereotypes have a huge impact on academic achievement and that girls' academic achievement can be identical

and surely also superior to that of boys, so there is no biological basis for differences in academic achievement.

Sometimes there are ideas that it is necessary to organize the learning process differently for girls and that perhaps STEM lessons should be organized in gender-separated groups. However, such a division is opposed by the results of studies that confirm that working together in mixed-gender groups contributes to a more inclusive environment [26] and can reduce gender stereotypes [27], which is contrary to research that shows girls can achieve higher results if they can work in a single-gender group [23]. The only way to resolve this contradiction is to reduce stereotypes and microaggressions against girls in the STEM field because gendered groups contribute to the formation of stereotypes.

It is essential for educators to be aware of the possible influence of stereotypes on academic achievements in the group of girls, as well as of various manifestations of microaggressions, which gradually push girls out of the STEM field. It is essential to apply pedagogical work strategies that have a positive outcome to the learning achievements of all students because the teacher's pedagogical activity can be both a support point and can create barriers for girls' achievements in the STEM field [28–30].

The objective of the present research is to analyze the data obtained and understand which pedagogical methods predictably have the greatest potential impact to increase academic achievement in the STEM field. Initially, the article analyzes the relevant literature on girls in STEM, then it describes the methodology used, the research design, and the findings, then discusses what was learned. This paper adds to the literature in several ways. First of all, these data were obtained in one specific country where, until now, no studies have been conducted on the factors that can increase educational achievements in the STEM field and it is important to understand whether the results of the study resonate with those conducted in other countries. Second, it compares several groups of students: students with high and low academic achievements and high- and low-achieving boys and girls. These data will enable the modeling of pedagogical processes to remove barriers to girls entering the STEM field. The results of this study will expand the understanding of attitudes toward STEM, academic achievement, and the meaning of pedagogical work from a gender perspective.

3. Disclosure of Context

This article is based on data obtained from European Social Fund Project No. 8.3.1.1/16/I/002, "support for the implementation of national and international events for the development of educational talents", but it should be pointed out that it only analyzes the data that provide answers as to which pedagogical methods have the greatest potential impact on improving academic achievement among groups of high- and low-achieving girls and boys in the STEM field. The rest of the data will be analyzed in future articles.

4. Methodology

For the purposes of this study, a survey questionnaire was developed, which included questions about student demographics, their learning achievements in STEM subjects in the previous semester, what subjects the students like, which activities in the classroom they consider to have an impact on their learning achievements, and which pedagogical work methods they recommend teachers use to improve learning achievements in STEM subjects. The questionnaire was developed based on results of the literature analyses on aspects that influence learning achievements in STEM. In the first step, the questionnaire was piloted with a small group of students (N 114). After the piloting phase, the results were discussed in the project group to agree on necessary corrections of the questionnaire. After the piloting phase, the necessary changes were performed and the questionnaire was distributed to the students.

The purpose of this project was to analyze girls' learning achievements in physics and mathematics, but the boundaries of the research were expanded in the survey, for example, by providing the survey questionnaire to both boys and girls, including questions about a

wide range of subjects, and sending it to all schools in Latvia. The data analysis takes into account not only the answers of girls with high academic achievements but also the answers of all girls and boys who participated in the survey. Regression calculations include not only mathematics and physics but also chemistry, computer science, programming, and biology. The data were obtained from 1847 students. Participation in the survey was voluntary and students could stop filling out the questionnaire at any time. Students from the 7th–12th grades were invited to participate in the study; there are two reasons for this. Firstly, schools start teaching such subjects as physics and biology from the 7th grade, prior to which they are included in the one subject of science. Secondly, 7th-grade students have reached the age of 13, which, according to the legislation in force in Latvia, is the age when a student can make an independent decision to answer the questions asked in a questionnaire if it does not require them to disclose sensitive information about the state of their health, family situation, etc. The data were analyzed to identify factors that have a statistically significant impact on academic achievement in STEM subjects by performing calculations both for the entire group of respondents and after dividing students, firstly, into groups with low and high academic achievements and, secondly, into groups of boys and girls irrespective of their academic achievements.

All ethical norms have been observed in the study and the anonymity of the respondents is guaranteed. The obtained data have been analyzed only in an aggregated form. The survey was administered through Google Sheets and the results were then transferred to SPSS for data calculation. The data calculation descriptive statistics and inferential statistics—regression analysis methods—were used to find out the extent to which the factors identified have an impact on learning achievement, which is the basis for further learning achievements.

5. Results

To be sure about the reliability of data, the Cronbach alpha was calculated for items used in the analyses and the results show that there is good internal consistency. It was 0.620 for the learning subjects that the students had to evaluate and 0.832 for the items that indicate different pedagogical strategies.

The questionnaire was filled out by 1847 students, of whom 1190 were girls and 657 were boys. Students could also choose the answer that they did not want to indicate their gender, but none of those who answered this question marked this option. The distribution of the number of respondents by their class group is even and there were 322 (17.4%) students from 7th grade, 426 (23.1%) from the 8th grade, 293 (15.9%) the 9th grade, 313 (16.9%) the 10th grade, 266 (14.4%) the 11th grade, and 227 (12.3%) from the 12th grade.

Students were asked to evaluate their attitudes toward different subjects on a 5-point Likert scale, where 1—I do not like it at all; 2—I do not like it much; 3—I am indifferent; 4—I like it; and 5—I like it a lot. The results of this evaluation show what subjects they prefer (see Figure 1) and these confirm that there are gender differences: girls mostly do not like physics and ICT and prefer arts, while boys mostly like sports and ICT.

The students were asked to evaluate the classroom environment by assessing what was offered to them that affected their desire to learn (see Table 1). The students had to rate their assessment using a 5-point Likert scale, where 1—it does not influence me at all; 2—it rarely influences me; 3—it sometimes influences me; 4—it influences me quite often; and 5—it influences me very often. It can be seen that girls in general evaluated all the proposed statements to be slightly more influential. Boys rated the opportunity to work in groups with their friends and the willingness of their classmates to learn higher than girls, but these differences are not statistically significant. The collected data show that the highest-rated factor was "the teacher helps me if I do not understand something" (M for girls = 4.61; M for boys = 4.32), which is not surprising since the teacher's role is to help students. The factor that has the least influence on the desire to learn is "if my classmates also want to learn a lot" (M for girls = 3.19; M for boys = 3.24).

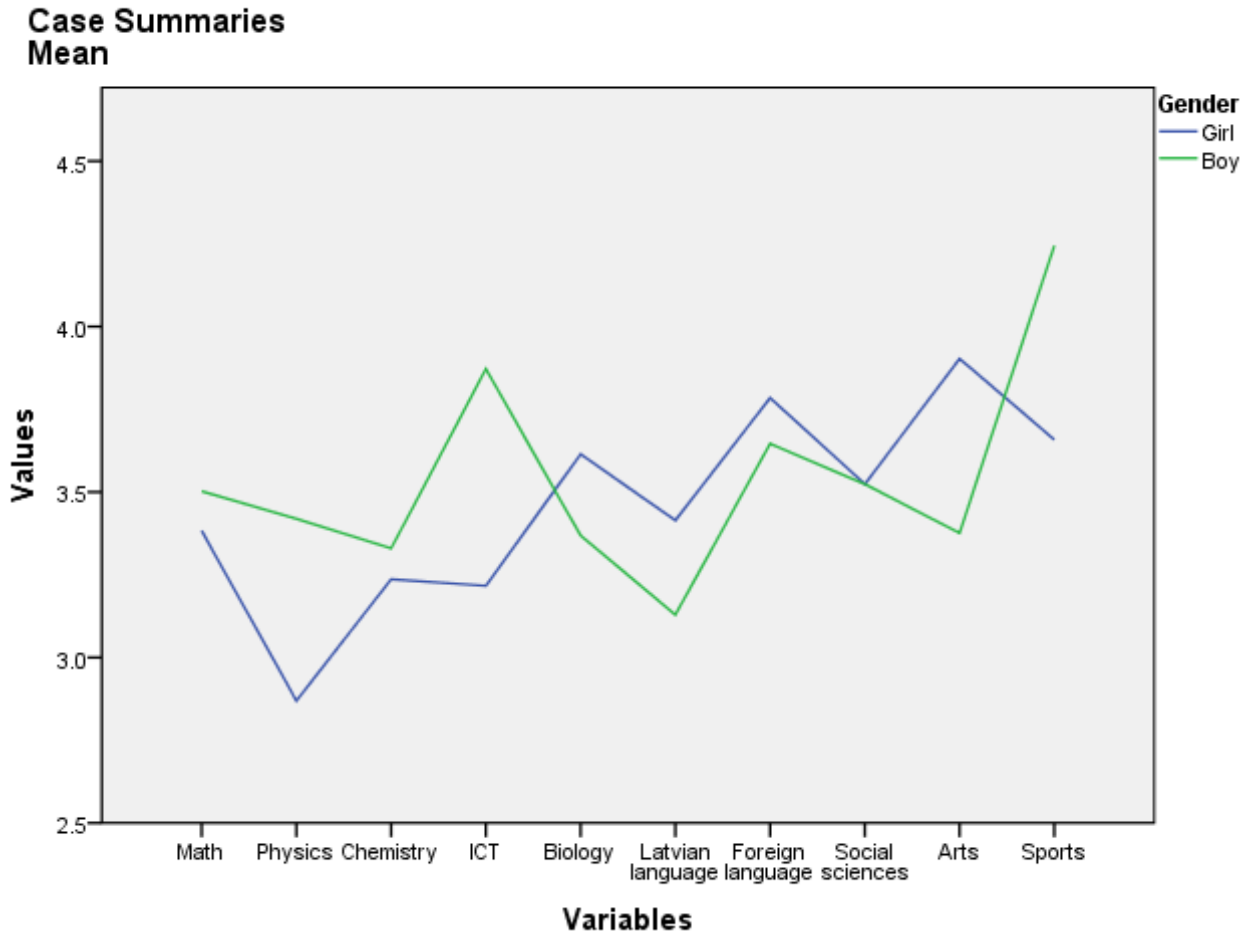


Figure 1. Students' attitudes toward learning subjects.

Table 1. Assessing factors affecting students' desire to learn.

	Girls		Boys		Total	
	Std. Deviation	**Mean**	**Mean**	**Std. Deviation**	**Mean**	**Std. Deviation**
The teacher conducts the lessons in an interesting way	4.40	0.790	4.17	0.901	4.32	0.838
The teacher comes up with various interesting activities	4.01	0.991	3.98	0.969	4.00	0.983
The teacher is fair to all students	4.38	1.446	4.10	1.035	4.28	1.321
The teacher is kind	4.37	0.843	4.06	0.947	4.26	0.894
The teacher helps me if I do not understand something	4.61	0.683	4.32	0.863	4.51	0.765
I am clear about how my work is evaluated	4.02	0.973	3.78	1.085	3.94	1.021
I can work individually	3.79	1.103	3.60	1.122	3.72	1.113
I can work in a group with my friends	3.84	1.143	3.91	1.115	3.86	1.133
I can work in a group with classmates of my own gender	3.24	1.401	3.32	1.338	3.27	1.379
I can work in different groups	3.50	1.207	3.50	1.187	3.50	1.199
I can succeed at what I do	4.33	0.870	4.05	0.967	4.23	0.916
If I can challenge myself with difficult tasks	3.50	1.144	3.56	1.084	3.52	1.123
If my classmates also want to learn a lot	3.19	1.281	3.24	1.239	3.21	1.266
If I know where to look for information	4.26	0.912	4.06	1.008	4.19	0.951

In the subsequent stage, students with high learning achievements in STEM subjects (math, physics, chemistry, and ICT), as well as biology, were separated, and these students were then subdivided into two groups: those whose grades in these subjects are 7.5 (out of 10) and below (students with low academic achievements) and those whose grades are 7.51 and above (students with high academic achievements).

The regression analysis includes questions about what subjects the students like, offering a choice of 10 subjects, and which of the 14 offered activities that take place in the classroom (see Table 1), in their opinion, affect students' learning achievements in STEM subjects.

Initially, the results of the group of students whose learning achievements in STEM subjects are lower than 7.5 were analyzed. The obtained results show that there are four statistically significant models that have an impact on the predicted learning achievements of students in STEM subjects. The ANOVA calculations show that all four models are statistically significant, but Model 4 has the greatest impact on increasing student learning achievements. The overall regression was statistically significant and results for the fourth model are as follows—R2 = 0.71, F = 4.132, $p \leq 0.043$.

As can be seen from regression analyses (see Table 2), the beta coefficient shows that the higher predictable outcome in STEM subjects is liking mathematics and the indicator "the teacher helps me if I do not understand something" in all models. In the fourth model, which has the most influential liking of mathematics, can increase learning achievements by 1.4, help of teachers by 2.12, and the possibility to succeed by 0.87. It can be concluded that students expect teachers to be kind, but it does not predict an increase in learning success. Students expect that teachers help them if they do not understand something, which is a strong predictor of learning success. This confirms that focused teacher support is needed more than just a kind personality, which does not support the learning of students whose learning outcomes are not high. In all of these models, liking mathematics emerges as a factor that predictably improves learning outcomes, implying that there is a strong emphasis on students being good at mathematics to predictably improve learning motivations across the STEM field.

Table 2. Coefficients_Low achievers_subjects_all students.

Model	Unstandardized Coefficients Beta	Standardized Coefficients Beta	Sig
(Constant)	5.169		0.000
Mathematic	0.140	0.170	0.000
The teacher helps me if I do not understand something	0.212	0.196	0.000
The teacher is kind	−0.129	−0.132	0.007
I can succeed at what I do	0.087	0.092	0.043

Next, regression calculations were performed for this group of students with low academic achievement in STEM subjects about the methods they would recommend teachers use and their predicted effects on academic achievement in these subjects. Students had to evaluate nine methods (group work, experiments, reading, etc.) on a scale from "never" to "all lessons" and the obtained results show that a statistically significant model for a predictable increase in learning achievement is "if teachers use individual tasks" and "if teachers ask us to analyze different examples". The overall regression was statistically significant and results for the second model are as follows—R2 = 0.33, F = 7.22, $p = < 0.007$. The R-square calculations show that the combination of such methods would predictably increase learning achievements in STEM subjects by 3.3%.

The beta coefficient shows that using "individual tasks", the assessment will increase by 1.25 points, and when using "analysis of examples", the assessment will increase by 1.26 points for the group of students with low learning achievements in STEM subjects (see Table 3).

Table 3. Coefficients_Low achievemers_suggestions_all students.

Model	Unstandardized Coefficients Beta	Standardized Coefficients Beta	Sig.
(Constant)	5.676		0.000
Individual tasks	0.125	0.121	0.005
Analysis of examples	0.126	0.116	0.007

Dependent Variable: Avg_5.

The next group analyzed was the students who have high learning achievements (over 7.5) in STEM subjects. In this group, two patterns emerge that predictably increase academic achievement, which are liking mathematics and chemistry. The ANOVA calculations show that both models are statistically significant and the R-square results show that for high-achieving students in the defined subjects liking mathematics and chemistry predictably increases their academic achievement in all STEM subjects by 7.6%, which confirms that the most important thing for high-achieving students to increase their learning achievements is liking the subject. The overall regression was statistically significant and results for the second model are as follows—R2 = 0.79, F = 16.212, p = < 0.000. No other indicators are significant in this group of students. Beta coefficients show that liking mathematics in groups of high achievers predictably increases grades in STEM subjects by 1.4 points, while liking chemistry predictably increases grades by 0.94 points (see Table 4). For this group, the activities taking place in the classroom are less important and the main driving force is their liking the subject, which means that the greatest emphasis in terms of pedagogical support should be placed on the stage when students develop an attitude toward one or another subject.

Table 4. Coefficients_High achievers_subjects_all students.

Model	Unstandardized Coefficients Beta	Standardized Coefficients Beta	Sig.
(Constant)	7.674		0.000
Math	0.114	0.184	0.000
Chemistry	0.094	0.171	0.000

Dependent Variable: Avg_5.

After performing regression calculations for the group of high-achieving students on the instructional methods they would recommend teachers use, the one that had a statistically significant effect on increasing academic achievement is reading; its predicted impact is 2.3%. The overall regression was statistically significant and the results for this model are as follows—R2 = 0.23, F = 13.586, $p \leq 0.000$. No other indicators are important for high achieving students.

The beta coefficients show that reading can predictably influence learning achievements in STEM for 1.15 points (see Table 5). This in turn demonstrates the importance of having appropriate learning materials for students to read to deepen their understanding of the subject.

Table 5. Coefficients_ High achievers_suggestions_all students.

Model	Unstandardized Coefficients Beta	Standardized Coefficients Beta	Sig.
(Constant)	8.133		0.000
Reading	0.115	0.156	0.000

Dependent Variable: Avg_5.

Next, the data of students were separated by gender and the group of girls with low academic achievement in STEM subjects was analyzed first. Here, again, the ANOVA calculations were performed to ascertain whether the data were statistically significant. Ten questions were included in the regression calculations, in which the students had to evaluate to what extent they like specific subjects and to what extent the activities taking place in the classroom influence the students. They expressed their assessments on a 5-point scale, ranging from "it does not influence me at all" to "it influences me a lot". The obtained results show that four models are statistically significant. The overall regression was statistically significant and the results for the fourth model are as follows—R2 = 1.25, F = 7.516, $p \leq 0.006$. However, interesting results emerge here, as in the strongest model, liking physics predictably affects academic achievement by 12.5%, but the beta coefficient shows that this liking for physics has a negative effect on predicted academic achievement in STEM subjects of 1.31 points for low achieving girls (see Table 6). This means that low-achieving girls dislike physics to a great extent, even to the point of affecting their academic achievement in all STEM subjects. According to the beta coefficients, a predictable increase in the results is for the indicators "the teacher helps me if I do not understand something" by 3.76 and liking mathematics by 1.48; these results are quite similar as for the general group of low achieving students where the help of teachers and liking of mathematics has a strong impact on predictable learning achievements. Similar to the case of the general group of students with low achievements, the negative effect is "the teacher is kind", where the predicted decrease in learning achievements in STEM subjects is 1.63 points, confirming that students understand that a teacher who helps them learn can increase their learning achievements, but they still believe that it is important for teachers to be kind.

Table 6. Coefficients_ Low achievers_subjects_girls.

Model	Unstandardized Coefficients Beta	Standardized Coefficients Beta	Sig.
(Constant)	5.231		0.000
The teacher helps me if I do not understand something	0.376	0.321	0.000
The teacher is kind	−0.154	−0.157	0.009
Math	0.148	0.188	0.001
Physics	−0.131	−0.155	0.006

Dependent Variable: Avg_5.

Next, the analysis turned to the questions where students had to recommend the frequency of the instructional methods used by the teachers on a 5-point Likert scale from "never" to "all lessons" and the obtained data show that in the group of girls with low learning achievements in STEM subjects, the model is statistically significant where "analysis of examples" and "individual tasks" are recommended. The overall regression was statistically significant and the results for the second model are as follows—R2 = 0.43, F = 5.287, $p \leq 0.022$. The predicted increase in academic achievements is 4.3% and the beta coefficients show that a predictable increase in STEM learning achievements for low achieving girls is by 1.53 points if the pedagogical strategy "analysis of examples" is used and by 1.34 points if "individual tasks" are provided (see Table 7).

A regression analysis of the group of boys with low learning achievements in STEM subjects, where the analysis includes the subjects that students like and classroom activities that students evaluate as important, was performed next, and the obtained results show that the statistically significant predicted learning achievements in STEM subjects are influenced by a liking for mathematics and the option "I can succeed at what I do". The overall regression was statistically significant and results for the second model are as follows—R2 = 0.64, F = 5.374, $p \leq 0.021$. Liking mathematics predictably increases learning achievement in STEM subjects by 4.5%, while "I can succeed at what I do" predictably

increases it by 6.4%. The beta coefficients show that liking mathematics can predictably increase the results by 1.88 points and "I can succeed at what I do" by 1.44 points for low achieving boys (see Table 8) and these results are in line with a general group of low achieving students where the liking of mathematics and feeling that one can succeed were indicators with positive predictable influences on improved learning achievements.

Table 7. Coefficients_ Low achievers_suggestions_girls.

Model	Unstandardized Coefficients Beta	Standardized Coefficients Beta	Sig.
(Constant)	5.609		0.000
Analysis of examples	0.153	0.146	0.010
Individual tasks	0.134	0.130	0.022

Dependent Variable: Avg_5.

Table 8. Coefficients. Low achievers_subjects_boys.

Model	Unstandardized Coefficients Beta	Standardized Coefficients Beta	Sig.
(Constant)	5.130		0.000
Math	0.188	0.213	0.001
I can succeed at what I do	0.144	0.149	0.021

Dependent Variable: Avg_5.

When performing regression calculations for boys with low learning achievements in STEM subjects on the methods they would recommend teachers use, "individual tasks" appears as statistically significant. The overall regression was statistically significant and the results for this model are as follows—R2 = 0.14, F = 4.278, $p \leq 0.040$. The data of adjusted R2 shows that the predicted impact of this indicator is of 1.4%. The beta coefficient shows that the predicted impact of this indicator is 1.38 points for improved learning outcomes (see Table 9). These results are quite similar for the general group of low achieving students and also for the group of low achieving girls and it means that low achieving students can succeed in STEM learning if they are provided with individual tasks.

Table 9. Coefficients_ Low achievers_suggestions_boys.

Model	Unstandardized Coefficients Beta	Standardized Coefficients Beta	Sig.
(Constant)	5.946		0.000
Individual tasks	0.138	0.134	0.040

Dependent Variable: Avg_5.

Subsequently, data calculations were performed on girls with high educational achievements in STEM subjects. The regression analysis for this group includes subjects that students like and what happens in the classroom that students consider important. The obtained results show that five models to increase the predicted academic achievement in STEM subjects are statistically significant. The strongest predictive value is for the model is where high-achieving girls can work with classmates of their own gender. The overall regression was statistically significant and results for the fifth model are as follows—R2 = 1.46, F = 4.373, $p \leq 0.037$. The adjusted R2 results shows that predicted academic achievement in STEM subjects can improve by 13.4% for the fifth model. The beta coefficient shows that a predictable increase in STEM learning achievements in the fifth model is in the amount of 1.29 if these girls like math, by 1,08 if they like chemistry, by 1.01 if they can succeed in what they do and by 0.47 if they can work in their own gender group. The predictable decrease

in learning achievements by 0.8 is if these girls work in different groups (see Table 10). In these results we can see the same pattern of results as it was in all groups that liking mathematics is a strong predictor of increased learning achievements; this has the same pattern as in the general group of students with high learning achievements that the liking of chemistry has a predictable influence, but indicators about working in particular groups are present only for girls with high achievements in STEM subjects.

Table 10. Coefficients_ High achievers_subjects_girls.

Model	Unstandardized Coefficients Beta	Standardized Coefficients Beta	Sig.
(Constant)	7.272		0.000
Math	0.129	0.229	0.000
Chemistry	0.108	0.210	0.000
I can succeed at what I do	0.101	0.139	0.005
I can work in different groups	−0.080	−0.166	0.003
I can work in a group with classmates of my own gender	0.047	0.114	0.037

Dependent Variable: Avg_5.

When performing regression calculations on girls with high academic achievements in STEM subjects on the methods they would recommend teachers use, "individual tasks" appears as statistically significant, with a projected 1.9% increase in academic achievement in STEM subjects. The overall regression was statistically significant and results for this model are as follows—R2 = 0.21, F = 8.255, $p \leq 0.004$. The beta coefficients also show that, for high achieving girls, the use of "individual tasks" predicts an increase in STEM learning achievements by 1.07 points (see Table 11). Such results are similar as for other groups where it was confirmed that individual tasks have a high predictable impact.

Table 11. Coefficients_ High achievers_suggestions_girls.

Model	Unstandardized Coefficients Beta	Standardized Coefficients Beta	Sig.
(Constant)	8.122		0.000
Individual tasks	0.107	0.146	0.004

Dependent Variable: Avg_5.

A regression analysis was also performed for the group of boys with high academic achievements in STEM subjects, which included the subjects that the students like and what happens in the classroom that the students consider important. The obtained results show that only one model (liking chemistry) is statistically significant for increasing the predicted academic achievement in STEM subjects. The overall regression was statistically significant and the results for this model are as follows—R2 = 0.19, F = 4.409, $p \leq 0.037$. The predicted increase in improved STEM learning achievements is 1.9%. The beta coefficient shows that the predicted increase in learning achievements for high achieving boys if they like chemistry is 0.99 points (see Table 12).

Table 12. Coefficients_ High achievers_subjects_boys.

Model	Unstandardized Coefficients Beta	Standardized Coefficients Beta	Sig.
(Constant)	8.071		0.000
Chemistry	0.099	0.158	0.037

Dependent Variable: Avg_5.

When performing regression calculations on high-achieving boys in STEM subjects on the methods they would recommend teachers use, "reading" emerges as statistically significant, with a projected increase in academic achievement in STEM subjects of 3.3%. The overall regression was statistically significant and the results for this model are as follows—R2 = 0.33, F = 6.710, $p \leq 0.010$. The beta coefficient confirms that the predicted improvement in STEM learning achievements for high achieving boys is 1.49 points if students are reading (see Table 13).

Table 13. Coefficients_ High achievers_suggestions_boys.

Model	Unstandardized Coefficients Beta	Standardized Coefficients Beta	Sig.
(Constant)	8.041		0.000
Reading	0.149	0.198	0.010

Dependent Variable: Avg_5.

6. Discussion

In almost all the analyzed groups, it can be seen that a liking for mathematics plays a statistically significant role in predicting an increase in academic achievement in STEM subjects. The only exception is in the group of boys with high academic achievements, where a liking for chemistry is the most influential model. This confirms that mathematics is a basic subject, the liking of which teachers should encourage because it has a positive effect on high learning achievements in other STEM subjects as well, which echoes the conclusions of other researchers [31].

For the group of all students with low learning achievements and the group of girls with low learning achievements in the STEM subjects, it is essential that "the teacher helps me if I do not understand something". For low-achieving boys, this is not a significant factor. In the group of all students with low learning achievements and in the group of girls with low learning achievements, "the teacher is kind" is statistically significant, albeit with a negative impact on learning achievement, which means that it is important for students to explain what they do not understand and learn in the process. They consider the teacher's kindness of little value if the teacher's desire to help in the learning process is not present. This feature is not significant for boys in any of the groups or for students with high academic achievements in STEM subjects. "I can succeed at what I do" is statistically significant for predicted improvements in academic achievement in STEM subjects in the group of all students with low academic achievements and boys with low academic achievements, as well as girls with high academic achievements.

Liking chemistry is a significant predictor of high academic achievement in all analyzed groups with high academic achievement in STEM subjects. The factors "I can work in different groups" and "I can work in a group with classmates of my own gender" are statistically significant models in the group of girls with high academic achievements, but working in groups without a gender division has a negative effect. This is interesting because when asking girls about what methods they would recommend teachers use, only one appears with a statistically significant pattern (using individual tasks), and this may indicate that girls want to work individually and take individual responsibility for their learning achievements. This may be because they have already experienced the effects of microaggressions on their academic achievements.

The importance of individual tasks to high learning achievements must be emphasized and this should definitely be taken into account when planning and organizing the pedagogical process in the classroom, where great emphasis is placed on group work. These results indicate that students still want to be individually responsible for the work to be completed and to understand the task individually.

A liking for physics is statistically significant in a model that predicts academic achievement in STEM subjects, but this factor has a negative effect on low-achieving girls.

This result is also very important when searching for the causes of such dislike. It is important to remember that in Latvia, physics is only taught as a separate subject from the 7th grade, which is also the lower age boundary for students involved in answering the survey. Therefore, we can conclude that those girls who have developed a dislike for physics most likely developed it before the 7th grade (13 years old). This indicates that it is important to think about how to teach physics to students at a younger age, promote students' understanding of it, as well as create an environment where girls feel safe and do not feel the effects of stereotypes and microaggressions. It should also be noted that a liking for physics does not have a significant effect on any of the other analyzed groups. Additionally, a liking for ICT or biology was not found to be statistically significant in any of the analyzed groups.

Of the students' recommendations to teachers about the methods that they use, "individual tasks" appeared as statistically significant in all the analyzed groups with low learning achievements and in the group of girls with high learning achievements, but it was not significant in the group of boys with high learning achievements. The "analysis of examples" tool is an essential recommendation for teachers, as it has a statistically significant role in predicting improvements in learning achievements in STEM subjects in the general group with low learning achievements and also in the group of girls with low learning achievements. On the other hand, there appears a statistically significant recommendation to use "reading" tasks more in the group of all students and in the group of boys with high learning achievements in STEM subjects. This means that boys with high academic achievements are aware of the need to read and delve into information in order to acquire new knowledge. This proves that it is essential to provide learning materials that students can read and discover new information about a subject for themselves. The results also confirm that a significant emphasis must be placed on mathematics in order to increase both students' interest in STEM subjects and learning achievements in this field, which will predictably increase the number of people who will choose to link their careers to STEM; research shows that increased requirements to learning achievements also have a positive effect on girls' involvement in the STEM field [32].

The results of the survey show that students wish to understand STEM subjects and they would like teachers to help resonate with the motivational development idea of the important role of self-efficacy [33,34] because it confirms that it is important for students with low learning achievements to feel they are succeeding, but this is not so important when students are already aware of the impact of their learning activities on learning achievements. The fact that this factor is significant for the group of high-achieving girls echoes the findings expressed by other researchers [35,36] regarding girls feeling more insecure about their academic achievements, so it is important for them to feel they are succeeding. The reason for this is probably related to the fact that they do not want to be exposed to various stereotypical comments or expressions of microaggressions from boys, which echoes the findings of other researchers that girls who perform well in the STEM field also feel the influence of stereotypes [10] and are able to perform better when working in a group of their own gender [23]. However, one should not assume the hasty conclusion here that these results indicate that it is necessary to divide students into gender-appropriate groups because such a division contributes to the formation of various stereotypes. It would be better to create environments where girls can act as equals in the learning process and not feel the influence of stereotypes or microaggressions.

The results of the survey confirmed that students do not wish that requirements to learning outcomes should be lowered. They are eager to learn more if there is pedagogical support, however, increased requirements for students' learning achievements must also be in synergy with the support provided by teachers if something is not understood, with the reduction in stereotypes and expressions of microaggression, and with the opportunity to perform tasks individually.

In the survey, the students could answer which profession they associate their future with and the data show that not only do a very small number of girls associate their future

careers with the STEM field, but boys only rarely associate their career choice with STEM as well. This is an extremely worrying fact and it is necessary to start thinking immediately about how to change this ratio. It is undeniable that such changes cannot happen in a short period of time, but it is also unequivocally clear that steps must be taken in the Latvian education system in order to change the situation. These should be rapidly growing actions to ensure a wide range of educational activities that contribute to the growth of knowledge in the STEM field.

7. Conclusions

Mathematics is a basic subject, the liking of which strongly predicts high learning achievements in STEM for all students; teachers should encourage and aim to ensure this. For high achieving boys, liking chemistry has a significant positive predictor. For low achieving girls, a liking for physics statistically and significantly predicts lower academic achievement in STEM subjects and it means that particular pedagogical strategies (individual pedagogical support, individual work, and feelings of success) should be used to improve girls' attitude to physics. The liking of other learning subjects included in the model—namely, Biology and ICT—do not have a predictable impact on learning achievements.

A strong predictable influence on STEM learning achievements has teachers' support when students do not understand something in low achieving students' groups as well as "individual work", which means that low achieving students cannot be let aside and they need individual pedagogical support. Such strategies as different kinds of group work do not support higher learning achievements.

Teachers' kindness plays an important role in learning but has a negative predictable impact on learning achievements. This result breaks a stereotype that if teachers are kind to students they will be eager to learn.

Students need to experience success and it was proved by the results that show that a high predictable impact on low achieving students has the indicator "I can succeed in what I do".

In a group of low achieving students, the indicator "analysis of examples" has a significant predictable impact on higher learning achievements.

Only in a group of high achieving girls does the indicator "to work in the same gender group" show a positive predictable influence on higher STEM learning achievements.

8. Future Research Directions

In the next steps of the research, the researchers will analyze the impact of stereotypes on students' learning achievements as well as the impact of teachers' actions on the formation of stereotypes.

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