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The Attitude of Visual Impaired Students towards STEM: A Pilot Study

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Abstract. Understanding and gathering information about the attitudes of visual impaired students concerning sciences, technology, engineering and mathematics (S-STEM) is an important issue for the school and for the teachers when planning inclusive classrooms in STEM context.

With the purpose of accessing the way visual impaired students relate to S-STEM, a questionnaire was applied in two samples of students from Portugal and Greece. The influence of sex, academic level, country and type of vision impairment was evaluated as main factors using a factorial ANOVA.

The analysis of the questionnaires showed that the academic level was the single factor with statistically significant effect on S-STEM. This drives to the conclusion that visual impaired students generally have a similar attitude towards S-STEM when comparing with other students.

Keywords. Blind, Inclusive Classrooms, Low Vision, STEM, Visual Impairment.

1. Introduction

The current labour market demands workers with good background in sciences, technology, engineering and mathematics (STEM) [1]. Responding to these demands raises two main challenges to the education systems related to STEM: attracting students and promoting efficient teaching methodologies.

In the case of inclusive classrooms with visual impaired students (VI), i.e., low vision and blind, extra efforts are necessary to adapt these methodologies to the students' visual condition. Thus, understanding the students' attitude toward STEM is a starting point to construct these inclusive processes. Therefore, this pilot study aims to assess the attitude of visual impaired students from lower and upper secondary education towards STEM in two European Countries.

Table 1. Information on students from different vision conditions

Country	Normal sight	Low vision	Blind
	n; mean age (years); SD	n; mean age (years); SD	n; mean age (years); SD
Portugal	25; 16.2; 1.2	7; 17.4; 2.2	4; 18.3; 1.5
Greece	26; 15.8; 1.5	13; 15.7; 2.8	8; 16.1; 2.4

n= number of students; SD=standard deviation

2. Methods

Thirty-six students, including normal sight, low vision and blind (8 males, 24 females; and 4 that preferred not to answer about their sex) from Portugal and forty-seven (24 males, 21 females and 2 that preferred not to answer about their sex) from Greece were enrolled in this study (Table 1). The Portuguese students' group, with an age (mean ± standard deviation) of 16.7±1.6 years old ranging from 14 to 19 years old and the Greek students' group, with an age of 15.8±2.1 years old ranging from 11 to 19 years old, answered a questionnaire about Student Attitudes toward STEM (S-STEM) [2] from November 2021 to March 2022. The questionnaire, as shown in Table 2, intended to assess five types of attitudes: Science, Technology & Engineering, Mathematics and 21st Century Skills. The response used a Likert scale: 'Strongly disagree', 'Disagree', 'Neither agree or disagree', 'Agree', and 'Strongly agree'. To these claims were attributed scores from 5 ('Strongly agree') to 1 ('Strongly disagree').

A mean score resulting from all four attitudes assessed was obtained for each subject and considered to represent the subject's S-STEM score, where higher numbers represent better attitude.

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Table 2. Questionnaire to measure Student Attitudes toward STEM (S-STEM) [2]

Skill	Item
Math	1. Math has been my worst subject. 2. I would consider choosing a career that uses math. 3. Math is hard for me. 4. I am the type of student to do well in math. 5. I can handle most subjects well, but I cannot do a good job with math. 6. I am sure I could do advanced work in math. 7. I can get good grades in math. 8. I am good at math.
Science	9. I am sure of myself when I do science. 10. I would consider a career in science. 11. I expect to use science when I get out of school. 12. Knowing science will help me earn a living. 13. I will need science for my future work. 14. I know I can do well in science. 15. Science will be important to me in my life's work. 16. I can handle most subjects well, but I cannot do a good job with science. 17. I am sure I could do advanced work in science.
Engineering and Technology	18. I like to imagine creating new products. 19. If I learn engineering, then I can improve things that people use every day. 20. I am good at building and fixing things. 21. I am interested in what makes machines work. 22. Designing products or structures will be important for my future work. 23. I am curious about how electronics work. 24. I would like to use creativity and innovation in my future work. 25. Knowing how to use math and science together will allow me to invent useful things. 26. I believe I can be successful in a career in engineering.
21st Century Skills	27. I am confident I can lead others to accomplish a goal. 28. I am confident I can encourage others to do their best. 29. I am confident I can produce high quality work. 30. I am confident I can respect the differences of my peers. 31. I am confident I can help my peers. 32. I am confident I can include others' perspectives when making decisions. 33. I am confident I can make changes when things do not go as planned. 34. I am confident I can set my own learning goals. 35. I am confident I can manage my time wisely when working on my own. 36. When I have many assignments, I can choose which ones need to be done first. 37. I am confident I can work well with students from different backgrounds.

To study whether vision affected S-STEM we applied the factorial ANOVA, where in addition to vision, sex, school level (lower secondary or upper secondary) and country were also used as main factors.

3. Results

The results presented in Table 3, Table 4 and Figure 1 show that vision does not affect S-STEM-score.

Of the other main factors, only the school level had a statistically significant effect, with lower secondary students having a better S-STEM.

Also, none of the interactions between main factors were statistically significant (Table 4). However, the interaction School-level*Vision was on the borderline of statistically significance ($p=0.051$). Therefore, School-level*Vision was reorganized into six groups, as depicted in Table 3 and Figure 1.

Table 3. Descriptive statistics per group

Group of students	Number of subjects	Mean (SD)
Lower secondary AND Normal sight	8	3.95 (0.44)
Lower secondary AND Low vision	9	3.52 (0.57)
Lower secondary AND Blind	4	2.84 (0.59)
Upper secondary AND Normal sight	43	2.96 (0.74)
Upper secondary AND Low vision	11	3.48 (0.54)
Upper secondary AND Blind	8	3.19 (0.43)

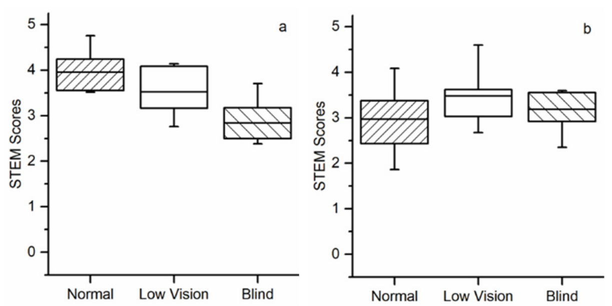

Figure 1. STEM Scores for students with normal vision, low vision and blind; considering two school levels: a) lower secondary and b) upper secondary. The box is determined by the 25th and 75th percentiles. The whiskers are determined by the 5th and 95th percentiles. The horizontal line represents the mean values

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A one-way ANOVA followed by a post-hoc tests (Tukey) was used to explore differences between these six groups related to S-STEM.

Table 4. Parameters (main factor and interactions) of factorial ANOVA

Factors	F	p-value
Country	1.7	0.19
School-level	7.5	<0.01
Sex	0.7	0.50
Vision	1.6	0.21
Country * School-level	0.7	0.40
Country * Sex	1.8	0.18
Country * Vision	0.5	0.64
School-level * Sex	0.5	0.58
School-level * Vision	3.2	0.05
Sex * Vision	0.6	0.64
Country * School-level * Sex	1.7	0.19
Country * School-level * Vision	1.3	0.28
Country * Sex * Vision	0.2	0.82
School-level * Sex * Vision	0.7	0.51
Country * School-level * Sex * Vision	-	.

The results showed statistically significant difference only between the lower-secondary-education-AND-normal-sight and upper-secondary-education-AND-normal-sight (one-way ANOVA: $F=4.36$, $p<0.01$; Tukey: $p<0.01$), which confirms that school level has a relevant effect on STEM score.

4. Discussion/Conclusion

In conclusion, VI students generally have a similar S-STEM to their counterparts with normal vision, indicating that the educational system/society does not demotivate these students for STEM. This can be a facilitator when planning inclusive STEM classes.

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