Greek teachers' and students' views towards STEM education

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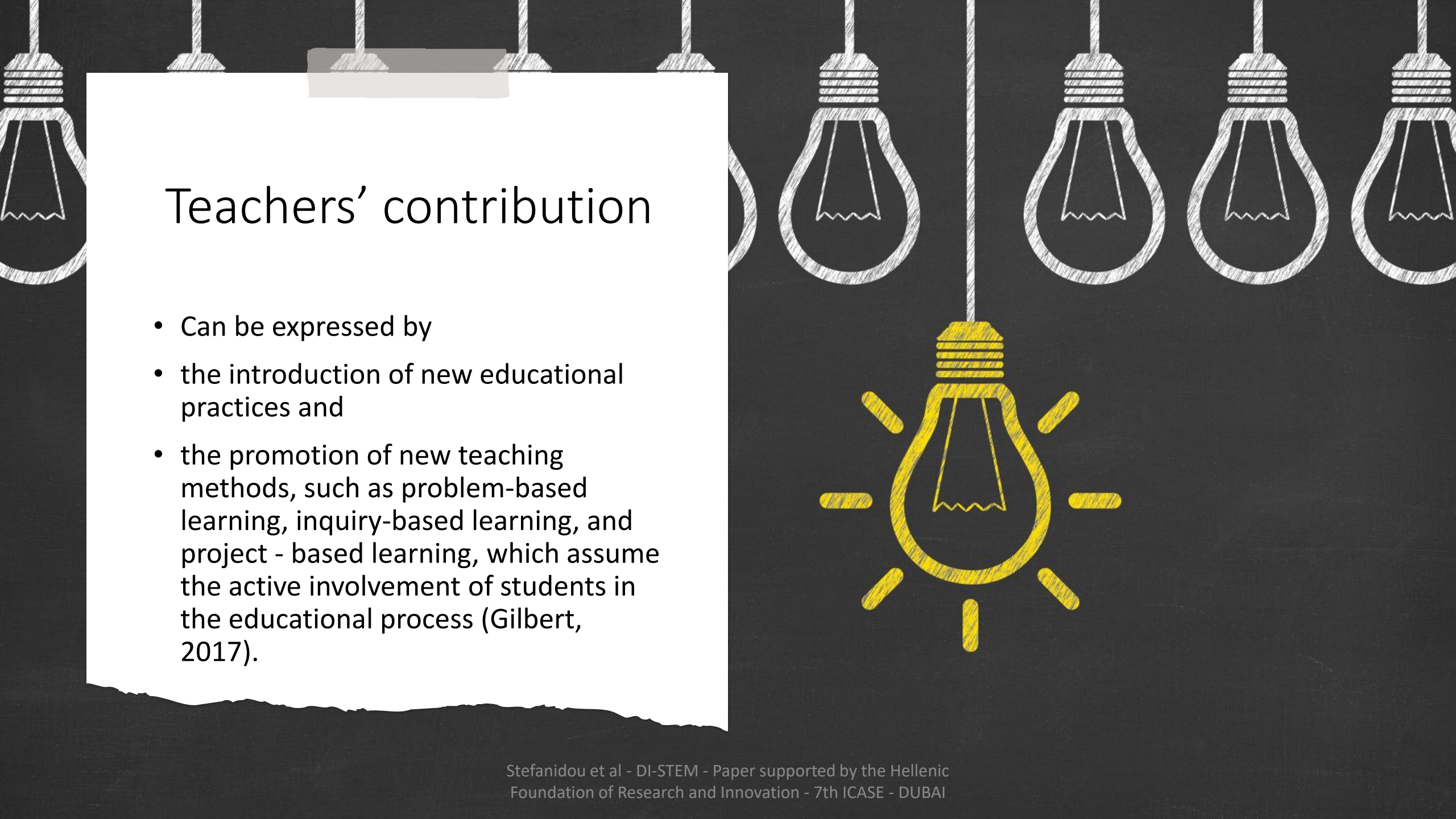
STEM education today

- The goal of STEM education is to promote scientific and technological literacy by
- cultivating skills and
- connecting learning to everyday life through familiarity with real problems (Havice, 2009; NRC, 2011; Hathcock et al., 2014; Du Plessis, 2018).
- Specifically, through STEM teaching, learners acquire skills that make them: a) problem solvers, b) innovators, c) inventors, d) self-reliant, e) logical thinkers, and f) technologically literate (Morisson, 2006; Shernoff et al., 2017).
- The shift of interest to educational activities that include design, coding and robotics paves the way for the development of the above skills, but also other skills such as critical thinking, creativity, collaboration, and communication.

Teachers' contribution

- Can be expressed by
- the introduction of new educational practices and
- the promotion of new teaching methods, such as problem-based learning, inquiry-based learning, and project - based learning, which assume the active involvement of students in the educational process (Gilbert, 2017).



Teachers' difficulties

- Difficulties in trying to make connections between the disciplines that make up STEM education (Kelley & Knowles, 2016) / individually teaching of the subjects / merely no connection with real-world applications (Breiner et al., 2012, Kelley & Knowles, 2016)
- which often results in a lack of interest on the part of students in both Science and Mathematics (Sanders, 2009)
- Research highlights that STEM teaching improves when teachers have sufficient content knowledge as well as pedagogical content knowledge (Nadelson et al., 2012).

Justification of the research

- Although there is a lot of literature that investigates the **development of STEM education** in several educational environments, there **is limited literature on students' and teachers' views on STEM approach.**
- To this line, this paper explores primary and secondary students' and teachers' views of STEM education.
- The paper is part of a work in progress, in which students' and teachers' views on STEM education are considered in order an educational program of three individual schools to be designed and implemented.

Research Questions (RQ)

- RQ1 What are Greek primary and secondary students' views towards STEM education
- The question is analyzed regarding

1. Mathematics and Science
2. Engineering and Technology
3. Environmental problems, and
4. Personal skills

- RQ2 What are Greek primary and secondary teachers' views towards STEM education
- The question is analyzed regarding

1. Students' skills in Mathematics and Science,
2. Students' technological skills,
3. Teaching Mathematics and Science

Sample

- Convenient and
- 69 Primary Education (PE) students (11- and 12-year-old students from a Greek rural area)
- 85 Secondary Education (SE) students (38 from an Evening Lyceum and 47 from a School of Second Chance)
- 6 primary teachers and
- 18 secondary teachers who belong to the corresponding schools.

Data collection

- Data were collected from February to March 2022.
- Among the students and the teachers in this research, no one had prior experience of STEM education in the formal education context.
- Their views rely either on general relevant knowledge or informal STEM education activities.

Students' views research tool

- A questionnaire consisting of 33 Likert Scale closed-ended questions:
- The questionnaire was structured in five (5) categories, according to the above-mentioned axes of the research question:
- five (5) questions explored students' views on Mathematics and
- five (5) questions on Science,
- eleven (11) questions on Engineering, Technology and their use in solving everyday problems,
- five (5) questions referred to environmental problems, and
- seven (7) on students' personal skills.

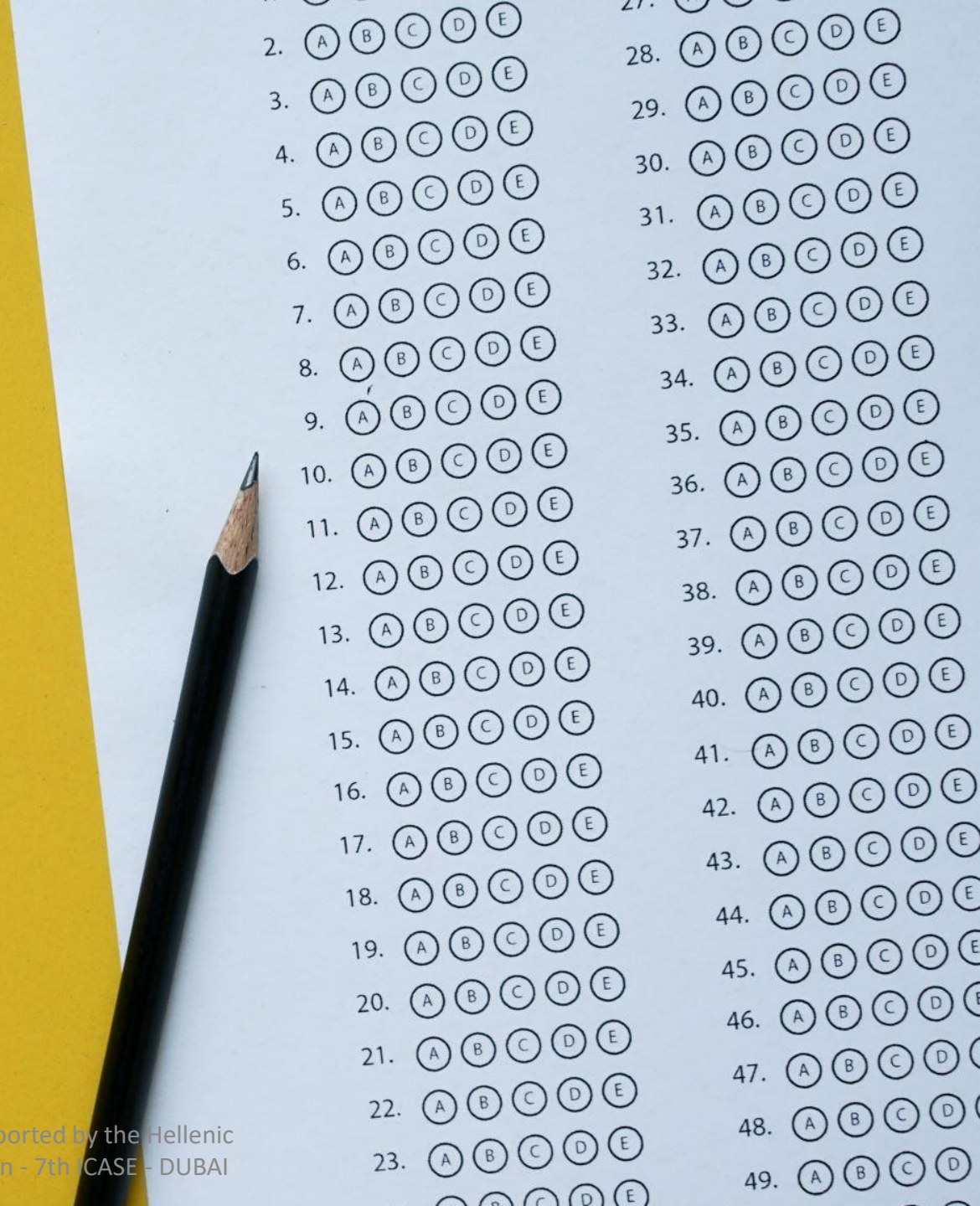
The tool was based on a questionnaire developed by North Carolina State University, the Friday Institute for Innovative Education and National Science Foundation.

Teachers' views research tool

- A questionnaire consisting of 23 Likert Scale closed-ended questions and 4 open-ended questions regarding STEM education.
- The questionnaire was structured in four (4) categories, according to the above-mentioned axes:
- eight (8) questions explored teachers' views on students' skills in Science,
- eight (8) questions explored teachers' views on students' skills in Mathematics,
- two (2) questions explored teachers' views on students' use of Technology, and
- five (5) questions explored teachers' views on their ability to teach Mathematics and Science.

Validity

- It is provided by the fact that all questions are related to students' and teachers' views on STEM education (content validity) and vice versa, the questionnaires include all aspects of STEM education, as they are classified in the four categories mentioned above.
- Moreover, the questionnaires are thoroughly tested by two experts, experienced schoolteachers. They both agreed on the content validity of all items (Polit & Beck, 2006).
- Finally, it was followed by clear instructions, written for primary and secondary school students and teachers to explain them how to complete the questionnaire.



Data analysis

- Regarding the closed-ended questions, they were sorted based on the pre-determined answer grades for each question and recorded in tables.
- The answers “much” and “very much” (grade 4 and 5 of Likert scale) were presented combined.
- Regarding the open-ended questions, qualitative content analysis method was used to analyze the data (Mayring, 2015). The results of the analysis of the open-ended questions are not presented here due to length limits of the paper.

Limitations

- Data for this research were collected from a limited number of PE and SE students and teachers. The inherent bias in convenience sampling (Hedt & Pagano, 2011), due to under-representation of subgroups in the sample, does not allow trustworthy inferences to be made about the intended population.

RESULTS – Primary and Secondary Students' views (1)

Students' views on Mathematics and Science:

Results reveal that PE students **feel more comfortable** both in Mathematics and Science classes than SE students since a bigger percentage of them find both subjects **easy and manageable** in comparison to SE students.

Almost all the PE students and more than half of SE students believe that **they can improve** their performance on both disciplines.

Half of the PE students and less than half of SE students **consider their future job related** to Mathematics and Science.

Finally, higher percentages of PE students state than they would like **to use the relevant knowledge in everyday problem solving**.

RESULTS – Primary and Secondary Students' views (2)

Students' views on Engineering and Technology

Both PE and SE students state **increased interest in machines and electronic devices** and **how they work** and believe to know how to combine Mathematics and Science to create new ideas,

They seem **disinclined following jobs** which include design, engineering, and constructing.

A possible explanation of the reluctance could be a lack of self-confidence which may be related to the lack of the teaching strategies that enhance applications of STEM disciplines in real life.

RESULTS – Primary and Secondary Students' views (3)

Students' views on environmental issues

Most of both PE and SE students showed increased interest in issues related **to environmental protection** and consider environmental problems of **utmost importance**.

Students are better informed about the **consequences** of such problems than the **causes**.

Most likely, because consequences are more discussed in public discourse in contrast with the causes that either are not discussed publicly to such extent or are discussed only between scientists.

RESULTS – Primary and Secondary Students' views (4)

Students' views on their personal skills

Both groups stated that they possess skills of **cooperation**, **mutual support, decision making, and can perform them in teamwork.**

The percentages for PE in this set of answers are higher in favor of teamwork skills, possibly because in SE teamwork is rather neglected, at least in Greece.

Findings showed that percentages regarding the use of relevant content knowledge in everyday life problem solving are relatively high. Students believe that when they finish school, they will be able to conduct mathematical computations, to evaluate science topics published in the news and social media and to solve practical problems using technology.

PE students remain more optimistic in this field as well.

RESULTS – Primary and Secondary Teachers' views (1)

Teachers' views about students' skills in Mathematics and Science

- Importance
- Both PE and SE teachers highly estimated as important developing problem-solving skills through small investigations among students and the use of measuring instruments and data collection tools, developing prediction skills and creating logical explanations of experimental results and making careful observations and measurements.
- Occurrence
- Despite PE and SE teachers' views about the importance of students' engagement in the above-mentioned scientific practices, they admit that their students do not have the opportunity to do that so often and systematically.

Table 5. *Teachers' views of students' skills in Mathematics and Science (much & very much or often & very often)*

	PE teachers: *How important do you consider your students, in the classroom or in the laboratory, to...*	**SE teachers:** *How important do you consider your students, in the classroom or in the laboratory, to...*	**PE teachers:** *In your classroom or lab, how often do your students...*	**SE teachers:** *In your classroom or lab, how often do your students...*
...develop problem-solving skills through small investigations that you suggest for them in Science, Mathematics and Technology	83%	89%	50%	50%
...work in small groups	100%	67%	67%	39%
...make predictions that can be tested experimentally	83%	83%	50%	72%
...make careful observations and measurements	67%	78%	67%	45%
...use measuring instruments and data collection tools	83%	89%	50%	50%
...recognize "patterns" in data	67%	89%	83%	45%
...create logical explanations of the results of an experiment or a small investigation	83%	83%	67%	39%
...share the results of their work with their classmates through small presentations made in class	67%	94%	33%	56%

RESULTS – Primary and Secondary Teachers' views (2)

- **Teachers' views on the use of Technology by their students**
- Most PE teachers believe that their students use technology quite often to communicate and cooperate in educational context, inside or outside the classroom, percentage that in SE is lower.
- On the contrary, PE teachers believe by 50% that students use quite often technology for finding information about a topic, while SE teachers believe the same for their students by 83%.
- Differences between the two sub-groups can be explained by difference in students age and their capacity in seeking information. PE students use technology to communicate more than SE students while SE students use technology to access resources and information.

RESULTS – Primary and Secondary Teachers' views (3)

Teachers' ability in teaching Mathematics and Science

- Most of them expressed
- Confidence to teach their subjects effectively
- Adequacy to help a student with difficulties in understanding
- Safety to provoke questions

- More SE teachers than PE teachers state that they know what to do in order to increase their students' interest.
- Although more positive students' views towards Mathematics and Science have been measured in PE than in SE.
- Therefore, in can be concluded that there is enough room for improvement in teaching practices in order to increase students' interest and such improvement is a driving factor for designing and implementing professional development training for teachers.

Table 7. *Teachers' views on teaching Mathematics and Science (very & very much)*

	PE teachers for **Mathematics**	SE teachers for **Mathematics**	PE teachers for **Science**	SE teachers for **Science**
I am constantly improving my teaching practices…	80%	78%	100%	80%
I feel confident that I can teach the subject effectively…	80%	78%	80%	80%
When a student has difficulty understanding a concept, I feel adequate to help him/her understand it better…	80%	78%	80%	80%
During teaching I feel safe enough to provoke questions from my students…	80%	78%	80%	80%
I know what to do to increase students' interest…	60%	78%	60%	80%

Conclusion

- **Based on students' views**
- most of them are self-confident regarding STEM disciplines and
- would like to use such knowledge in solving everyday life problems.
- they are eager to know how machines and electrical devices work, despite that they do not intend to follow a relevant career in engineering or technology, and
- they are interested in environmental issues
- they strongly declare that are capable for teamwork, to support each other and to take decisions after discussion and argumentation, skills that are important for STEM education.

Conclusion

- **Based on teachers' views**
- they seem to have difficulties in teaching through a STEM approach
- they acknowledged that STEM approach has many advantages and promotes significant skills of their students, on everyday teaching practice
- BUT they do not develop them accordingly
  - This probably happens due to lack of infrastructure, financial resources, and scientific equipment.

Further research

Although the findings of this study cannot be inferred to national level, they give basic directions for implementing STEM education in the classroom, and specifically in vulnerable settings.

Students' and teachers' views ask for further research on the benefits and the difficulties that may arise during the implementation of STEM activities in the described schools. To this respect, the present study gives rise to further research on training teachers and engaging students in STEM activities in those settings.

The findings provide the necessary material for designing professional development training for teachers for implementing STEM approach in Primary and Secondary Education.

Additionally, it is a matter of research how the schools under consideration could constitute fertile educational environments for the diffusion of STEM education to more teachers and students having similar needs.

Thank you for your attention

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