SUNRAISE - Stem UNlimited Raise thanks to Arts at School in Europe

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PR1: Analysis of the achievement of STEM skills in EU and the need for a more interactive approach

NATIONAL REPORT CYPRUS

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1. The importance of STE(A)M

In the 21st century, STEAM, an approach to teaching, has attracted attention over the more well-known STEM. STEAM, as a newly emerged model by Goergette Yakman (2016), incorporates 'Arts' in the "traditional" STEM model. By using Science, Technology, Engineering, the Arts, and Mathematics as entry points for student inquiry, discussion, and critical and high order thinking, STEAM aims to develop various skills necessary in different fields of innovation and progress[1].

Even students who choose a career in a field other than one of the STE(A)M fields can find STEAM education significantly beneficial as the skills acquired from such an educational approach can be translated into almost any career. That is the case as students are taught how to learn, how to ask questions, how to experiment and how to create, besides merely being taught the subject matter.

The addition of art into lessons does not serve as a means of increasing the attractiveness of STEM but it also contributes to the increased value and effectiveness of the STEM curriculum. A recent study by Inoa, Weltsek and Tabone (2014) reported that students whose language arts curricula were infused with theatre arts often outperformed their control group counterparts, whose course lacked arts integration, in both math and language arts[2]. Also, in Brouillette and Graham's 2016 study, students from grades 3 to 5 in high poverty elementary schools in California, were significantly benefited from just nine hours of STEAM instruction and illustrated improvements in their science achievement3. These findings show that STEAM is an effective educational methodology, and it could be particularly helpful for students with socio-economic difficulties.

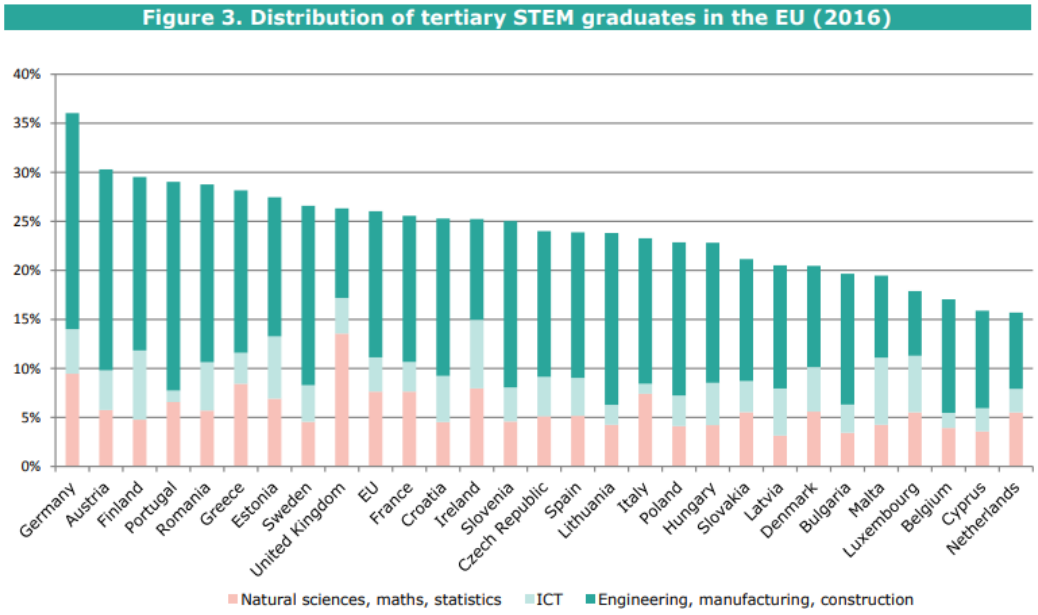
[1] https://www.researchgate.net/profile/Georgette-Yakman-2/publication/327449281_What_is_the_point_of_STEAM-A_Brief_Overview/links/5b901b98a6fdcce8a4c2f290/What-is-the-point-of-STEAM-A-Brief-Overview.pdf
[2] Inoa, R., Weltsek, G., & Tabone, C. (2014). A study on the relationship between theater arts and student literacy and mathematics achievement. *Journal for Learning through the Arts*, *10*(1), n1.
[3] Brouillette, L., & Graham, N. J. (2016). Using arts integration to make science learning memorable in the upper elementary grades: A quasi-experimental study. Journal for Learning through the Arts, 12(1).

1. The current situation in Cyprus

1.1 STEM Education in Cyprus

Although employability rates have increased among young Cypriot graduates in 2019, graduates from the fields of STEM subjects remain scarce in Cyprus (Education and Training monitor, 2020). Importantly, Cyprus has fewer STEM graduates than most EU countries with the percentage of STEM graduates in comparison to the EU average which was 25% in 2018 with the share of Cypriot STEM graduates being just over 15% in 2016, 15% in 2017[4], and dropping to 9.8% in 2018. This limited percentages occurs while Cyprus enjoys one of the highest percentages of Tertiary Education Graduates. In STEM related professions the demand is high while the supply is scarce (European Commission, 2018c).

Figure 1. *Distribution of tertiary STEM graduates in the EU (2016).*



Looking within the group of STEM graduates, only one in three STEM graduates is a woman (36.2%) in Cyprus. In 2019, the proportion of female STEM graduates in relation to the total

[4] https://ec.europa.eu/newsroom/rtd/items/680749/en

number of female graduates was 7.7%, in contrast to an EU average of 14.7%, with a decrease of 2.6% compared to 2014 (10.3%).

The proportion of STEM graduates in Cyprus in 2021 (Education and Training monitor, 2021), was at 13.8%, again reaching the lowest proportion of STEM graduates in the EU.

Looking more specifically within the group of Cypriots with degrees in STEM subjects, 2.4 % of graduates obtained a master's in natural sciences, mathematics and statistics, which is the lowest percentage of the aforementioned masters graduated in the EU. At 1.5 %, ICT master graduates is also among the lowest in the EU. However, at PhD level this trend is reversed, with the highest share of graduates having studied natural sciences, mathematics and statistics (26.7 %) followed by engineering, manufacturing and construction (18.9 %). While this data is positive, only 3 % of all students were enrolled in PhD programmes in 2014/2015 (European Commission, 2018d) so STEM is a very small part of overall degrees. Therefore, according to ETM in 2018[5], there is a clear need to increase the attractiveness of STEM subjects among Cypriot youth in order to develop STEM skills and follow such careers that are central to innovation (HRDA, 2017).

Conclusively, these statistics place Cyprus in the countries with the least STEM graduates consistently over the last years and an even smaller percentage of women in STEM subjects, despite the fact that there is a very high tertiary level education in Cyprus that enlarges the challenge of overqualification[6]. Therefore, there is a great need to enhance students' interest in STEM subjects and increase the attractiveness of STEM-related careers in the country. Recently, it has been recognized that there is a strong need to enhance young people's STEM profiles to help minimize some of the issues that were highlighted during the COVID-19 mobility restrictions. Cyprus aim is to improve skills pertaining to STEM education through the EU recovery and resilience Facility[7].

[5] European Commission. 2018. Education and Training Monitor – Cyprus.
[6] https://education.ec.europa.eu/sites/default/files/document-library-docs/et-monitor-report-2018-cyprus_en.pdf
[7] https://op.europa.eu/webpub/eac/education-and-training-monitor-2020/countries/cyprus.html

1.2 Student achievement in STEM subjects

The percentages of Cypriot students underachieving in reading, mathematics, and science have raised concerns within the Cyprus Government. As a result, Cyprus government has started making efforts to improve this field by operating the STEM education programme in nine All-Day Optional schools (Primary Education), promote mandatory education from the age of four, and adopt a Literacy Program (running in all Gymnasiums).

According to the National Reform Programme (2022), STEAM projects including training at the school level, are at the center of attention when it comes to plans for the minimization of unequal opportunities and gender inequality[8].

2. Cyprus' Recovery and Resilience plan

The modernization and digitalization of STEM education is financed with a budget of EUR 13.8 million by the Cyprus' Recovery and Resilience Plan, between 2021 and 2026[9]. A variety of projects will be financed to digitally transform schools and improve skills in science, technology, engineering and mathematics (STEM), including:

- purchasing digital equipment (tablets/laptops) for students from less socio-economically advantaged backgrounds.
- purchasing digital equipment for schools.
- training 3375 teachers (representing approximately one third of all primary and secondary teachers) in digital skills and STEM methodology.
- Implementing changes to curricula and developing educational material for the development of digital and STEM skills.

These objectives are part of Reform 4. The overarching objective is the transformation of the curriculum and the development of the educational material to improve information and data literacy, communication and collaboration, digital content creation, safety and problem solving. A related goal is to provide students opportunities to acquire the 21st century skills (collaboration and teamwork, creativity and imagination, critical thinking, problem-solving)

[8] https://ec.europa.eu/info/sites/default/files/nrp_cyrprus_2022_en.pdf

[9] http://www.cyprus-tomorrow.gov.cy/cypresidency/kyprostoavrio.nsf/all/B37B4D3AC1DB73B6C22586DA00421E05/$file/Cyprus%20RRP%20For%20Upload%2020052021.pdf?openelemen

and the improvement of students' learning outcomes. At the core of this initiative is also the incorporation of STEAM teaching methodology.

3. STEM legislation in Cyprus

In Cyprus, there has never been an educational law designed specifically for the promotion of STEM subjects and skills in secondary education. However, recently a project named 'STEM program' has been implemented in primary schools. STEM began to acquire an identity in the context of Cyprus as this program aimed to address the limited preparation of students for STEM subjects in education and future stem-related job opportunities.

The first reference by the Department of Secondary and Tertiary education was made in 2010, when they stressed the need to extent the number of students enrolled in programmes associated with STEM and to align the Cypriot educational policy and vision therewith of the EU that focuses on research and development for smart economic growth.

4. Secondary School system

Secondary Education in Cyprus is provided for students aged 12 to 18 and remains compulsory until the age of 15. For public schools, education is offered through two three-year cycles – Gymnasium (middle school) and Lyceum (high school). After completing Gymnasium, students can either go to General Lyceum or choose to attend Technical High school (Vocational school), also falling into the category of High school, but providing pathways relevant to technical trades such as engineering, architecture, graphic design and more. There are currently 62 Gymnasiums (middle schools), 38 Lyceums (high schools), 12 Technical High schools (vocational secondary school) and 8 joined Gymnasiums and Lyceums (located in rural areas) all over Cyprus[10]. Private schools - depending on the type of school - follow their own curriculum, syllabus, and tuition fees. Currently, there are 38 Secondary Private Schools all over Cyprus.

[10] http://archeia.moec.gov.cy/mc/363/en_public_secondary_general.pdf

In the first year of High School education (Lyceum in Cyprus), students choose one of the four available Subject Orientation Groups or 'Pathways', which include a default combination of courses and some optional modules all related and leadinh to six corresponding educational directions. These directions include: a) Classical and Humanity studies; b) Foreign Languages and European Studies; c) Fine Arts; d) Applied Sciences / Biosciences / Informatics & Technology; e) Economics and f) Commerce and Industry. Additionally, school in Cyprus provides basic knowledge through compulsory modules (Greek, Civics, Religious education) in order to allows students to continue their studies on university level but also provide more specialized knowledge on the pathway of choice to allow students access to free labour market[11].

The percentage of schools in Cyprus providing essential equipment to support digital education, such as laptops, computers, cameras and interactive boards, is lower than the average percentage across EU at both primary and secondary levels. Only 40% of middle schools and 59% of high schools offer the necessary equipment to support digital tools as opposed to 54% and 84%, respectively in Europe.

The annual Circular of the Cypriot Ministry of Education and Culture (MoEC) has repeatedly highlighted the need for teachers and schools in general to develop students' employability skills[12][13]. In response to this need for skill development at school, seminars on critical thinking, creativity, artificial intelligence, lifelong learning skills, new teaching approaches for STEM subjects and the use of ICT tools in teaching STEM, were announced in 2007 and 2018 for teachers and school principals to participate on a voluntary basis[14].

In order to enhance digital and STEM skills, the National Coalition for Digital Jobs has introduced cost-free digital certification for students and school competitions in some STEM fields such as coding and robotics. Courses on computer science are also taught in all-day primary schools and secondary schools (ETM, 2018)[15].

4.1 The case of Mathematics

[11] Annual Report (2018). Ministry of Education and Culture in Cyprus. URL: http://www.moec.gov.cy/etisiaekthesi/index.html
[12] Annual Report (2005). Ministry of Education and Culture in Cyprus: http://www.moec.gov.cy/en/annual_reports/Annual-Report-2005-EN.pdf
[13] Annual Report (2010). Ministry of Education and Culture in Cyprus.
[14] http://enimerosi.moec.gov.cy/d/dme
[15] https://education.ec.europa.eu/sites/default/files/document-library-docs/et-monitor-report-2018-cyprus_en.pdf

It is important to highlight the fact that the only STEM subject which remains compulsory across all 6 grades in public secondary schools in Cyprus is mathematics. The same course for Mathematics is provided to all students in Gymnasium but the course might differ in Lyceum depending on students' individual choice of Pathway. Importantly, all students regardless of their pathway have to undertake classes on Mathematics and its assessment via the Pancyprian Examination, the final examination for the award of secondary school certificate, is mandatory to all students. However, students whose pathway focuses on more scientific subjects (Applied Scineces/Biosciences/Informatics & Technology OR Economics) have to undertake 'Advanced' or 'extended' mathematics which is different to the subject 'General Mathematics' undertaken from students of any other pathway. These two courses vary in terms of the syllabus and students are taught more hours when taking the Advanced Mathematics course (see table 1). An examination in mathematics is essential for every student graduating from secondary school in Cyprus, either in General Mathematics or Advanced Mathematics.

4.2 Other STE(A)M subjects

The STEM subject of Physics is also a compulsory module in the last two grades of high school. All students at public high schools, regardless of their pathway, have to take 1 period of Physics every week, and its syllabus contains concepts and principles relating to sciences and engineering[16]. Students are also taught IT for 2 periods per week until the 1st Grade of Lyceum but afterwards, they need to select the specialized or advanced IT course otherwise there is no general IT course. Likewise, the course 'Design & Technology' stops being offered after 1st grade of High school unless the specialized version of the course is selected as part of their pathway. Students in the 1st grade of high school onwards take different STEM subjects which are compulsory regardless of their pathway as soon in table 1 below:

Table 1. *STEM subjects teaching periods (45-minutes) in public Gymnasiums and Lyceums in Cyprus.*

Gymnasium						
Subjects	**Mathematics**	**Physics**	**Biology**	**Chemistry**	**IT**	**Design & Technology**
A' Grade	**5**	**0**	**2**	**0**	**2**	**1,5**
B' Grade	**4**	**2**	**1**	**1**	**2**	**1**
C' Grade	**4**	**2**	**2**	**1**	**2**	**1**
Lyceum						

[16] http://archeia.moec.gov.cy/mc/49/katefthynseis_a_lykeiou.pdf

Subjects	Mathematics		Physics		Biology		Chemistry		IT		Design & Technology	
	*G	*P	G	P	G	P	G	P	G	P	G	P
A' Grade	3	5	2	4	1	1	2	2	2	2	2	2
B' Grade	3	7	1	5	-	4	-	4	-	4	-	4
C' Grade	3	7	1	5	-	4	-	4	-	4	-	4

Table adapted based on https://nop.moec.gov.cy/index.php

Notes:
*G – General lessons, compulsory for all students.
*P – Pathway lessons, maximum hours of 'specialized' or 'advanced' lessons provided in pathways.

When it comes to Arts, it is only compulsory for 1 period until the 1st grade of high school and then only students who select the Fine arts pathway can continue taking this subject at public secondary school in Cyprus.

5. STE(A)M Initiatives in Education

5.1 STEM Program in Primary schools

Since 2019, the STEM program in Primary Education has been implemented in Cyprus. More specifically, the Council of Ministers approved on May 15, 2019, the proposal of the Ministry of Education and Culture, for piloting the implementation of the Program STEM in Primary education, with the aim of achieving modernization and enrichment of the Schools' programs. Through this program, students would be offered authentic learning opportunities, which will assist their acquisition of necessary 21st century skills, such as creativity, problem solving, communication and importantly, the ability to plan and analyze.

According to the decision taken, the program would be implemented as a piloting for the academic year 2019-2020 in nine primary school, in the afternoon time, as an optional subject. The nine schools were selected on the basis of specific criteria, such as geographical location (at least one primary school from each town in Cyprus), logistical infrastructure, student population and operation or absence of an afternoon study zone within the Optional Full-Day School institution. In optional Full-day School, students have a lunch break, study hour and the STEM program was designed to be added after the completion of lunch and study hour.

The program was launched for two consecutive 45-minute periods after school closing, twice a week. For the effective supervision of the experimental, analytic, and practical nature of the program's execution, there were between 7 and 13 students in each group. Teachers that took

part in the STEM program in primary schools had obtained a Master's degree in STEM education and teaching methods. This program would be available for the 6th grade (senior) students only. However, in some cases, where necessary for the purposes of completing and operating departments, the programs were available to 5th grade students as well.

5.2 National Competitions fostering STEAM

The University of Nicosia organises an annual competition with the title *"Research by Students*" and invites students from Middle, High and Technical schools to submit their team-based innovative projects that can focus on social sciences, applied sciences, economics or healthy.

The Research and Innovation Foundation in Cyprus, a public organisation launched in 1996, organises an annual competition entitled "*Students in Research*". The aim of this competition is the cultivation of a research and innovation culture in young students. Also, students of primary and secondary education are expected to become familiar with scientific research processes. Through this competition students are encouraged to go through various stages of the research and development process, such as formulation of hypothesis, methodology, data collection and analysis, experimentation, interpretation of results and presentation of a research process. The competition improves their communication abilities, teamwork, critical thinking, creativity and initiative. Research topics include among others Sustainable Development, Information and Communication Technologies, Health and Biological Sciences, Technology, while interdisciplinary approach is encouraged.

5.3 Sci-tech Challenge program

In order to address the limited number of STEM graduates in Cyprus and promote careers in STEM fields, JA Cyprus and ExxonMobil Cyprus announced the launch of the new Sci-Tech Challenge program in 2021. The initiative dates to 2010, and since then 67,000 students have been involved, from different European countries including Romania, Bulgaria and more. Sci-Tech Challenge is designed to motivate students of secondary education, aged 15-18, to consider career paths in science, technology, engineering, and mathematics (STEM). The goal is to raise awareness of the importance of STEM education and how they can be applied in resourceful ways to meet future challenges.

For the implementation of the programme, an ExxonMobil mentor visits the classroom for 90 minutes and talks to students. A total of 10 teams across Cyprus (1 team per participating school) will participate in the second Sci-Tech Challenge in Cyprus that will be taking place in April 2023. For this programme, schools need to register via an online application in order to offer students from their school the opportunity to participate in this programme as it is not provided for individual students but only in participating schools. After presentation and an interactive quiz, students are presented a challenge. Subsequently, they have to come up with solutions to the challenge which will be presented by the end of the program. This year, the team with the best solution will represent Cyprus to the European Sci-Tech Challenge in Spring 2023. Similarly, in the past, winning teams would represent Cyprus in various competitions, for example the Pan-European Sci-Tech Competition in May 2021[17].

6. Best Practices

There has been a renewed interest towards actions concerning the improvement of taching STEM subjects and following STE(A)M approach, starting from kindergarten to high school. Many universities, organizations and STEM centers have been working on different projects and initiatives recently, and the following subsection renders an overview of such important actions on a national level, some of which are available for free while others require a fee to be paid by participants.

6.1 STEM programme and Robotics Academy

At Grammar School, a private school in Nicosia, the *STEM programme* has been officially introduced into its curriculum since 2015. Grammar School (secondary school) and Grammar Junior School (primary school) are the only schools in Cyprus that have incorporated STEM in the curriculum. The aim of this project is to educate students in four specific disciplines-Science, Technology, Engineering and Mathematics – in an interdisciplinary and applied approach. Rather than teaching these subjects as separate ones, the programme integrates them

[17] https://jacyprus.org/en/2022/04/sci-tech-challenge-in-cyprus-the-opportunities-in-stem-domains-for-the-new-generation/

into a cohesive learning paradigm. The STEM programme follows a teaching approach relying on applied knowledge and structured inquiry-based learning which requires students' active and creative contribution. Students learn by doing, designing, making and programming robots or other equipment. The STEM programme aims at improving students' critical thinking, team building skills and creativity. Additionally, it provides the knowledge required to emphasise active real-world problem-solving in collaboration with intelligent technology where students are able to create, programme and design applications and real-life scenarios. The programme takes place four times a week and provides students with basic knowledge in different topics, including science and engineering principles, computer programming languages, science experiments and motorized mechanisms, new media design, robotics, data analysis, 3D model and design, mobile app development and web technologies to name a few.

Furthermore, students have the opportunity to join the *Robotics Academy*, an Academy set up as an extracurricular activity at Grammar School that aims to promote team spirit, leadership and event-organising skills. The aim of the Academy is for students not only to develop the aforementioned skills, but also to gain experience in STEM-related careers in a creative and innovative way. In the Robotics academy, students learn the basics of building and programming miniature robots using LEGO MINDSTORMS, practice decision making and evaluation of possible solutions. Finally, members of the Academy are selected to take part in Science and Robotics competitions and fairs at a national and an international level and receive further intensive training so that they can participate in National Robotics Competitions hosted by the WRO (World Robotics Organisation) and the Google Science Fair or the World Robot Olympiad.[18][19]

6.2 The STEAMers program

The STEAMers is a programme based on the standards of S.T.E.A.M Centers and organized by the Youth Organization across three towns in Cyprus: Nicosia, Limassol and Paphos. The program offers a variety of workshops in Robotics, Programming, Photography, Graphic Design, which refer to the 'STEM' subjects as well as Music, Theatre, Art and Dance for the 'A' in STEAM. The workshops are aimed at children and young people and are offered by professional trainers.

[18] http://www.grammarschool.ac.cy/easyconsole.cfm/id/1542
[19] https://simerini.sigmalive.com/article/2019/4/20/to-stem-sto-grammar-school-nicosia/

The main goal of these workshops is the promotion of healthy employment, entertainment and learning as well as the cultivation of expressiveness and creativity. It also aims at the support of participants' psycho-emotional empowerment and personal development. During workshops, participants have the opportunity to familiarize themselves and experiment with new programs, acquire new skills and cultivate their interests in STEAM subjects. Participants can enroll in whichever workshop they wish and the total annual number of sessions per workshop is 30. The participation in these workshops is not free[20].

6.3 Initiatives for girls

6.3.1 STEM Summer Camp (teenage girls)

As part of a campaign for the promotion of girl participation in STEM subjects, Frederick university organized a four-day workshop in Nicosia, targeting girls aged between 13 and 16. This set of workshops took place between the 4th and 8th of July 2022 at Frederick University campus in Nicosia and offered teenage girls the opportunity to explore, experiment, construct and solve problems using ingenuity, analytical thinking and imagination in order to come into direct contact with STEM subjects. With the support and design from different departments of Frederick university, the event included workshops with the following:

- Study, design and build a bridge (Department of Civil Engineering and Department of Architectural Engineering)

- Make a canvas with coloring compounds (Pharmacy Department)

- Play music by assembling an electronic circuit (Department of Electrical, Computer and Informatics Engineering)

- Programmed a robotic vehicle using senses and logic (Department of Electrical, Computer and Informatics Engineering)

- Learn about building and driving a Formula Race car (Department of Mechanical Engineering)

In particular, staff members from the Departments of Civil Engineering, Architectural Engineering, Pharmacy, Electrical Engineering, Computer Engineering and Informatics and the Department of Mechanical Engineering participated in these workshops. Additionally,

[20] https://thesteamers.onek.org.cy/

partners of the University also contributed to the implementation of the STEM Camp. For example, the Mediterranean Institute of Gender Studies (MIGS) held workshops to empower girls and the PwC Experience Center visited the workshops and met young girls.

Alongside the workshops, teenage girls had the opportunity to participate in experiential activities for career guidance, empowerment, and self-development. The program also included visits to relevant organizations and held meetings and discussions with women who excel in STEM fields and who functioned as a source of inspiration towards young girls with an interest in STEM subjects.

This four-day workshop action is part of the university's long-term campaign with the title 'To all women and girls: Join the journey in Engineering, Science and Technology'. The campaign is under the auspices of the Gender Equality Commissioner and part of this action is funded by the National Mechanism for Women's Rights. women in these fields, who can be a source of inspiration for girls of all ages. Importantly, this action offers 50% scholarships to all girls who choose to enrol in an undergraduate program of the Polytechnic School of Frederick university.

6.3.2 GEM Summer School 2021

A similar initiative, a summer school, focusing on girl empowerment in STEM took place from June 22nd to 25th in 2021. This summer school with the topic title of 'Colours Uncovered' was organized by the University of Nicosia (UNIC).

The purpose of the GEM Summer School was to engage girls with STEM activities and placed emphasis on improving their understanding of the role of STEM and particularly, the entrepreneurial potential of the field. More than 12 female scientists and educators worked together to develop interactive activities on the topic of "Colours". The girls, in small groups learnt about colours and their importance from the perspective of science, mathematics, technology, engineering and the arts. They collaborated on the production of final products and their presentation to others. Participants also had the opportunity to work with female scientists, visit an environmental centre as part of a field trip and create a plan for the promotion of their products. Each day at the Summer camp involved different activities, all revolving around the topic 'colours' as summarized below:

1. Day 1: Introduction to the science of colours, drew a scientist activity, discussion on light and colours, Observation of bubbles in terms of colours, consistency and size.

2. Day 2: The role of colours in the environment, the use of materials from the environment to produce colours, and the technology of materials.
3. Day 3: Importance of color in chemistry, interviews with a female scientist, member of the Cypriot epidemiological team, design of s new uniform.
4. Day 4: Visit to the STEM Freak Center and learned about entrepreneurial skills in STEM, Familiarization with 3D printer and programming, Work on Final project and product promotion.

6.3.3 Girls in STEAM academy

The girls in STEAM academy is a 2021 innitative whose aim is to empower and inspire girls to follow a career in STEAM. On the 17th and 18th of September, Girls in STEAM academy organized two full-day events related to the BridgeSTEAM project. This project is a gender-related program designed to encourage middle school girls to apply science, technology, engineering, arts and math (STEAM) skills and concept through research based hands-on learning. As an intensive programme, it aims to empower and support young girls in learning more about potential career paths and opportunities in STEAM fields. BridgeSTEAM will also hold future events in the cities of Limassol and Larnaca in November and December, respectively, in an attempt to support young girls' careers in STEAM across districts in Cyprus.

The bridgeSTEAM programs of girls in STEAM Academy had been previously successfully completed in 2021 as well. Similar to 2022, trainers, female role models with careers in STEAM and volunteers enriched the program with their contribution[21][22].

6.4 Other Summer camps

6.4.1 Engino STEM & Robotics Camp

Another initiative that took place over the summer, was a paid STEM summer camp organized by Engino Education. This camp lasted 5 days, starting on the 29th of August 2022 and completed on the 2nd of September 2022. Participating students should be aged between 9 and 24 years old. The camp was held in Rodon Hotel, in the village Agros in Limassol.

[21] https://steamacademycy.org/
[22] https://cyprus-mail.com/2022/08/03/programme-for-teen-girls-interested-in-steam/

The camp included lessons on Mechanics, where children would understand simple and complex machines and their functions, in an attempt to comprehend the usefulness of everyday machines. Another set of skills which was developed was problem-solving skills since it is a core element of the STEM methodology, and such skills are useful for all children when searching for solutions to every day problems. An introduction to Science was also part of the camp, via experiential projects with the active participation of all children. SThrough educational robotics, children understand ways of building and programming robots, constantly updating on current technological developments. Finally, children learnt to think algorithmically. Experiential learning was also the focus of interesting activities on mathematics. Finally, in addition to sports and other games, students were given a tour to the Engino factory, and expanded their knowledge of 3D printing and design.

At the end of each activity, children were asked to apply knowledge and values that they had acquired through Building Engino Models and Programming Competitions. All these activities happened in a gamified way with the award-winning toy system 'Engino'[23].

6.4.2 STEAM for PEACE camp

STEAM for Peace and Entrepreneurship is a camp specifically designed for middle school/gymnasium students (aged between 10-13) and has the goal of providing an enjoyable way of spending summery holidays while doing some hands-on science experiments on STEAM simultaneously. This is a bicommunal initiative that aims at developing students' knowledge in STEAM subjects in a group of students from the two communities from all over Cyprus. The camp is designed with the theme of peace in a way of introducing friendship, collaboration and peacebuilding in a fun learning environment.

The camp is organised by a team of young, dynamic Cypriot STEAM lovers and scientists and is sponsored by the Alumni Engagement Innovation Fund (AEIF) by the U.S. Embassy in Cyprus.

STEAM for Peace and Entrepreneurship Camp contained a number of activities on Science, Technology, Engineering, Arts and Maths subjects integrated in an enjoyable forms of not only hands-on science experiments, but also the form of interactive workshops, discussion groups,

[23] Engino Summer Camp 2022

competitions and games. It was a 3-day long Day Camp that took place in the historical Ledra Palace Hotel's graen in the UN controlled Buffer Zone in Nicosia Cyprus on weekdays throughout July and August In 2022, with 5 groups of 3-day camps throughout these two months. Each camp group consisted of 20 students. Attendance at the camp was free and students had to submit an online application form in order to attend the camp.

6.5 Best practices by companies and organizations

6.5.1 She can STEM. Deloitte

The leading company Deloitte Cyprus has recently announced the She.Can.STEM mentoring program. This program offers tailored, one-to-one mentoring sessions with professional from Deloitte company and is targeted at Cypriot female university students, who are either pursuing an undergraduate or postgraduate degree in the field of STEM. The mentoring relationship that She.Can.STEM offers has a duration of 9 months, starting from November and finishin in June, and it includes 1-hour sessions on a monthly basis. Through these sessions, Deloitte professionals who act as mentors support students along their skills building and employability journeys. The main aim of this program is to support young women from STEM subjects by providing career advice, individual guidance and improving confidence in the sector, and ultimately supporting their employability in STEM.

Apart from the mentoring program, Deloitte also organizes the 3-week She.Can.STEM internship program that targets on female students in secondary education. This programme accepts students from public lyceums, at least 16 years of age, and private schools, also at least 16 years of age. This program is paid and apart from individual coaching sessions with Deloitte participants, students hear guest speakers who are experience professionals in STEM fields, and importantly, they gain work experience across STEM-related services and personal development workshops. The Stem relates service lines include the following:

- Technology counsulting
- Financial advisory – Data analytics
- Cyber risk
- IT audit
- Assurance

6.5.2 RISE Graduates First 'STEM and Gaming' Summer Scholars

In 2019, 15 young people completed RISE's first "STEM and Gaming Summer Scholars" Program—a unique summer opportunity for high-school students interested in STEM fields and gaming technologies. Designed to act as an integrator of academic research and industrial innovation, RISE sees its Summer Scholars Program as one way to expose them to cutting-edge methods and Research in Interactive media, Smart systems and Emerging technologies – RISE. Each student received a Certificate of Participation at an event at RISE's temporary offices at PwC's headquarters in Nicosia on Friday, July 12, 2019.

RISE is a centre of excellence in Cyprus focused on Research, Interactive media, Smart systems and Emerging technologies. Its aim is to become a centre of excellence that integrates academic research and industrial innovation through knowledge and technology transfer on the island and in the region. It is a joint venture between the three public universities of Cyprus (University of Cyprus, Cyprus University of Technology, Open University of Cyprus), the Municipality of Nicosia, and two renowned international partners, the Max Planck Institute for Informatics (Germany) and University College London (UK). RISE will fuel scientific, technological, and economic growth in Cyprus and Europe harnessing the power of research to improve the marketplace and solve real-world problems.

7. RESULTS FROM RESEARCH CARRIED OUT BY THE SUNRAISE PARTNERS – CYPRUS

7.1 Research Methods

This section provides information relevant to participants' background and the methods employed in conducting research in Cyprus. Information for each question is supplemented by graphs.

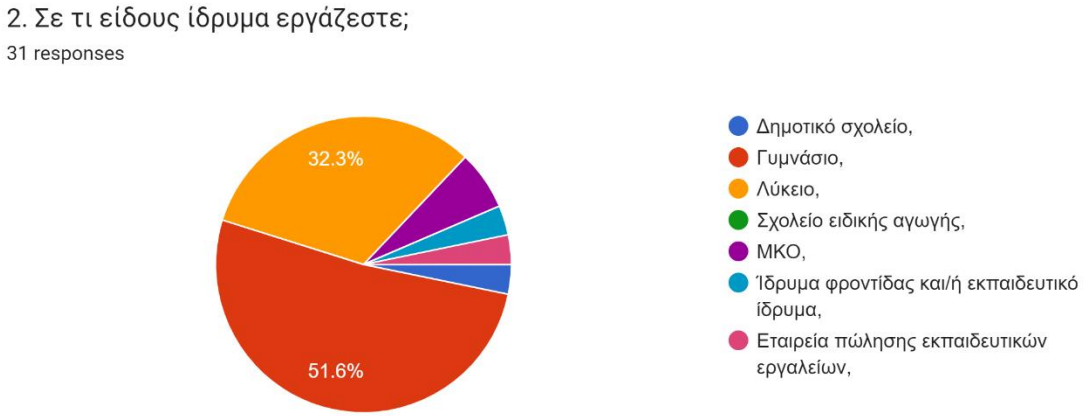
7.2 Participants

In total there were 34 participants that responded to the survey. The survey was administered online via Google forms and a link was sent to schools and/or individual teachers, and educational institutions.

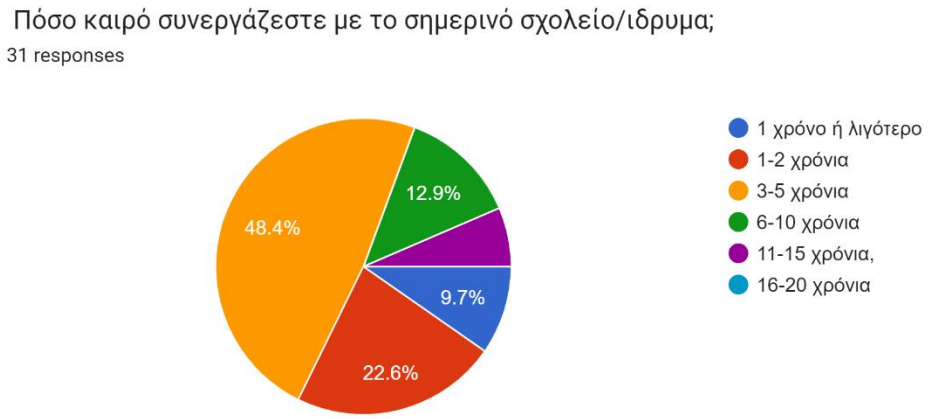
30 of the respondents said that they are currently a teacher of STEM subjects while just 4 are not currently teaching STEM. Among the 30 who teach STEM subjects, these were the subjects of their expertise:

1. Mathematics (7 responses)
2. Design and Technology (4 responses)
3. Physics (3 responses)
4. Biology (3 responses)
5. IT (2 responses)
6. Chemistry (2 responses)
7. Geography (1 response)
8. Science (1 response)
9. Computer security (1 response)
10. Sustainable development (1 response)

The participants of the survey were employed in different types of educational institutions, though the majority (51.6%) were employed at Gymnasium, or Lower Secondary Schools. Ten participants, corresponding to 32.3%, are educators in Lyceum, or High School/Higher Secondary School. 1 educator is employed at Primary school, 1 is employed at a company for educational material, 2 are employed at NGOs with projects on STEM education, and 1 works at an educational center/institution.



the majority of the respondents (48.4%) have between 3-5 years of work experience at the current school/institution, 22.6% had an experience of either 1 or 2 years there, and 12.9% of the respondents had between 6 and 10 years of experience. Three respondents had no more than one year of experience at their current workplace while 2 participants had between 11 and 15 years of teaching experience at their current workplace.



The vast majority of the participants (75.8%) were permanent employees at their workplace, 18.2% have a fixed term contract of a duration of more than one year while just one participant

has a fixed term contract of a duration of less than one year and one participant is a self-employed educator.

Regarding participants' educational background, 61.8% of the participants had a bachelor's degree in a STEM-related subject while 38.2% of the participants, that is 13 individuals, had a master's degree too.

7.3 Knowledge of STEM

To the question 'Can you decode the acronym STEM' the overall responses were very positive as only 1 out of 34 respondents claimed to 'not know' what STEM stands for and were not able to decode its acronym (Science Technology Engineering Mathematics). There were some variations in decoding 'Engineering' that related to the translation of the word in Greek but regardless the decoding showed understanding of the term.

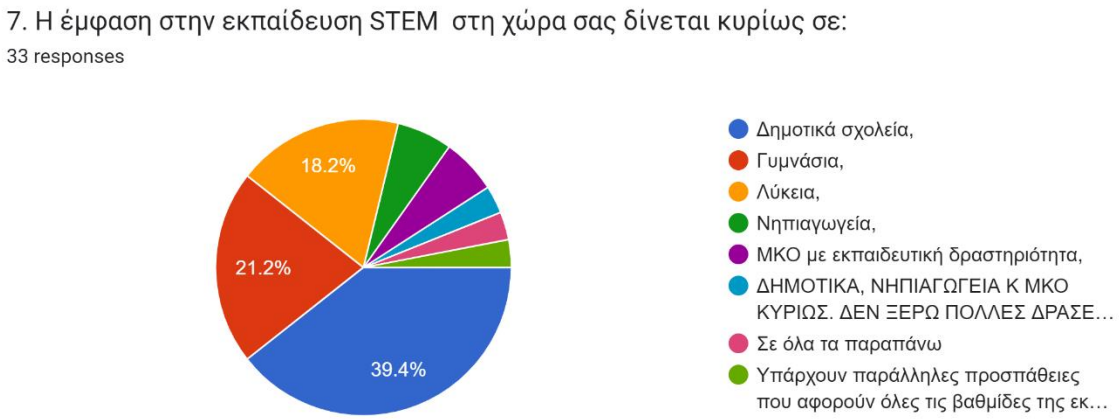
Regarding STEAM, participants were asked if they could identify the difference between STEM and STEAM. Although the majority of the respondents (64.7%) responded positively, 35.3% responded negatively corresponding to 12 respondents not knowing the difference between STEM and STEAM. Subsequently, 23 respondents stated that 'A' refers to 'arts'. One individual respondent stated that STEAM includes arts and creative skills in general while another respondent clarified that although in the parts A stood for arts (painting, photography, literature, poetry and theatre among others), nowadays it is considered as 'all other non-stem subjects'.

7.4 STEM school subjects/scientific disciplines in Cypriot Schools

As found in the desk research of the study, it was confirmed by educators in the survey that schools are, with different denominations depending on the level (first or second level secondary school) and type of institution (Technical Institutes, General Lyceum or Technical Lyceum). Respondents listed different sciences while some respondents pointed out that science education is provided through a single Integrated Sciences subjects in Primary education, though it does not include chemistry or physics but focuses strongly on environmental education. For secondary education, participants listed the following subjectsL Physics, Chemistry, Biology, Geography, Computer Science/Information Technology, Mechanics, Environmental education, Technology and Design. It was further clarified that in Technical/Vocational Lyceums there are additional and more advanced optional subjects such

as courses on Mechanics and Electronics which are not offered in General Lyceum. The difference between private and publics schools was also mentioned by one respondent who said that in private schools the subjects are taught at GCSE and A level but they are optional besides mathematics which need to be taken by all students. Similarly, a few more respondents mentioned that in Public General high school, mathematics are mandatory across high school but only students who enroll in two pathways, the Practical pathway offers subjects mainly on sciences while physics, chemistry and geography stop being compulsory for students of different pathways.

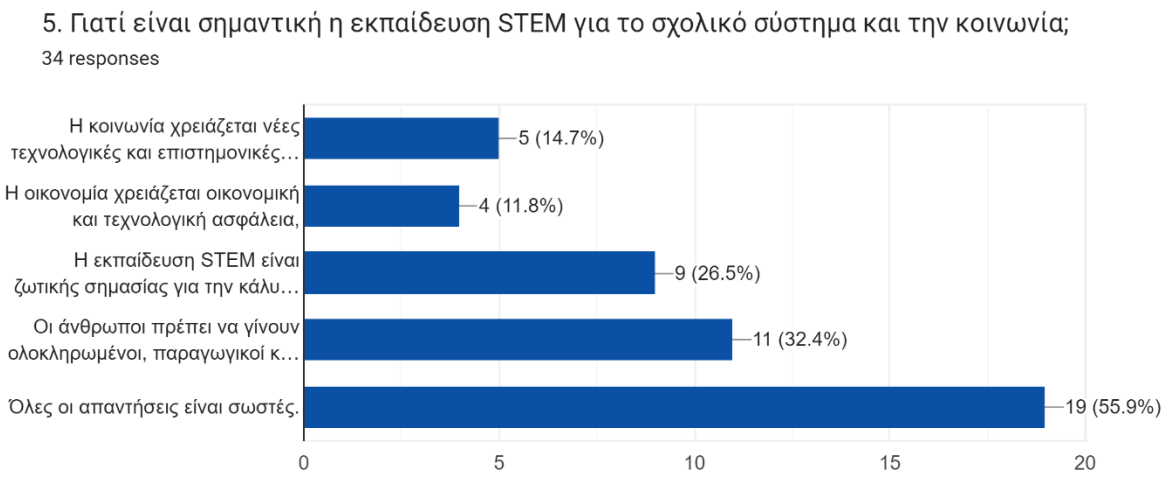
When it comes to the question 'At what level is STEM education given more importance?', there were some mixed responses. Fourteen of the participants (42.4%) stated that more emphasis is given in Primary education, between the ages of 6 and 12 years old. Seven respondents (21.2%) stated that more emphasis is given in Gymnasiums, so lower secondary education, while three respondents said in kindergarten, that is pre-primary education. Three respondents mentioned NGO that undertake educational activities. Two respondents (6%) stated that there are actions throughout school years, from pre-primary education to secondary education.



7.5 Perceived importance of STEM in educational system and the society

To the question 'why is STEM education important for the educational system and the society?', 11 respondents (corresponding to 32.4%) stated that STEM is important because it helps people become complete, productive and informed citizens. 9 respondents stated that STEM is of vital importance in supporting the needs of a constantly changing world. Just 4 participants stated that the economy needs financial and technological safety supported by

STEM education while 5 participants agreed that the society needs technological and scientific advancements supported by STEM education.



Importantly, the majority of the respondents (19) at the percentage of 55.9%, claimed that all ideas mentioned are correct, therefore, placing the importance of STEM in technological and scientific safety and advancements, in the development of productive and complete individuals that can support the needs of modern day society with all the changes it undergoes constantly.

To the general question 'is STEM education important in your country' most respondents were positive (73.5%), 6 respondents (17.6%) did not have an opinion to share whereas only 3 respondents (8.8%) claimed that it is *not i*mportant.

In elaborating on the importance of STEM education in Cyprus, there was a plethora of responses. Firstly, the minority of participants who claimed that STEM education is not important in Cyprus said that educators are not fully trained on teaching STEM and many methods central at STEM education are not included in the teaching recommendations and material provided by the Ministry of Education.

The rest of the respondents mentioned that STEM helps create individuals that possess skills necessary nowadays, who can solve problems in real life, have cultivated critical thinking skills instead of merely memorizing information, and follow a relevant occupation. The skills mentioned relevant to STEM education were both hard and soft skills. It was further mentioned that through STEM education, learners become independent users of technology and can think creatively and outside the box instead of following predesignated routes. It was mentioned that there is need for the development of such skills that combine sciences and explain today's

world in order to allow young people find possible solutions to problems, for example through tool creation, in order to improve the quality of life. Another idea mentioned was that STEM education makes learning in general more enjoyable for young people. Overall, many ideas were shared about the importance of STEM education even by participants who claimed that perhaps not a lot of importance is placed on STEM in Cyprus at the moment.

7.6 STEM Skills

To the question 'which skills students develop are the most important and relevant to STEM education' there was a predominance in 'Problem solving' by precisely half of the respondents, 17 (50%). The second most important STEM skill for students was 'Computational thinking' at 17.6% with 6 responses. 5 responses (14.7%) mentioned 'Analysis' while equal responses (2 corresponding at 5.6% each) were given for other skills such as teamwork, self-development, and action planning.

7.7 Further perceptions of STEM education

Participants were later offered some sentences to which they had to express their extent of agreement on a Likert scale.

Firstly, to the argument 'The thing that differentiates STEM education from traditional education of sciences and mathematics is that it shows students how the scientific method can be applied in real life', 21 respondents answered 'agree', 11 respondents answered 'strongly agree', and just two respondents gave 'Neutral opinion'. This shows that overall participants agreed on the differentiation of STEM with traditional education and its importance in showing students the application of STEM subjects and principles in real lie.

Secondly, participants were asked to show their extent of agreement to the sentence ' the educational staff at your school makes attempts to support STEM education in students with disabilities'. To this argument, there was less overall favour agreement. Ten respondents answered 'agree' and 9 answered 'disagree' while the majority (14 respondents) had a neutral opinion, neither agreeing nor disagreeing.

Participants were later asked a more specific question in order to understand more specific actions and solutions provided for students with disabilities for better supporting STEM learning. Four respondents answered that they were not aware of any such attempts but specified that it always depends on the specific disability. Other respondents gave some

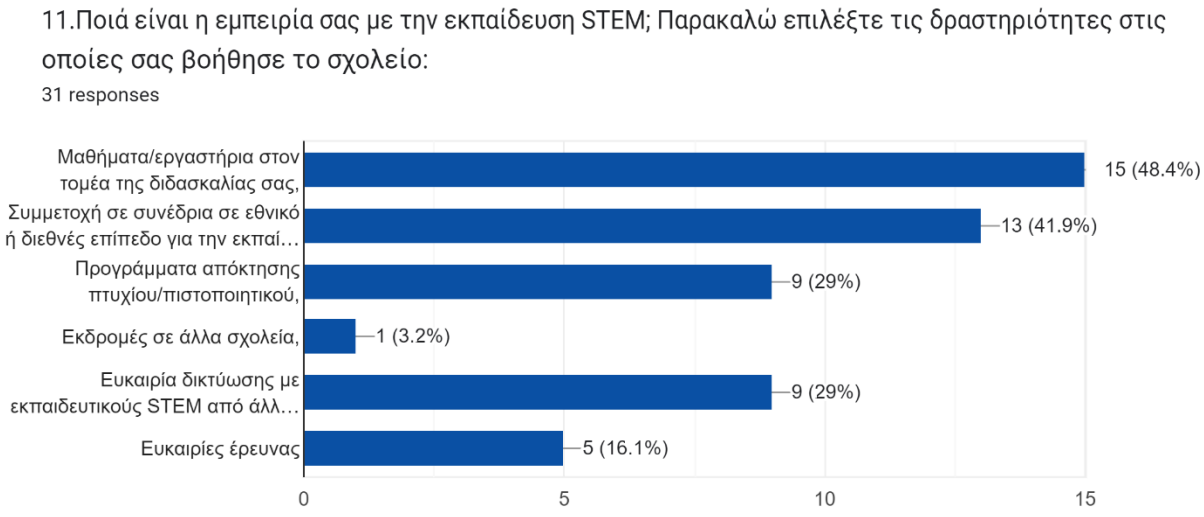
insights on techniques or methods currently used. For example, it was mentioned that there is software for the support of students with visual disabilities and books with modified fonts again for students with vision problems. Supplementary material was mentioned for students with learning disabilities as well as additional time during assessment by educators again for students with learning difficulties. Another respondent stated that educational staff do not voluntarily make attempts for the support of students with disabilities but makes attempt since they are part of their responsibilities and duties and are mandatory in the educational system as mentioned by the Ministry of Education. The final argument made was the use of experiential learning based on experiments with items.

Further, participants were asked to show their degree of agreement to the argument 'school staff have good knowledge of STEM subjects', to which there was a variety of responses. The majority of respondents, 13 in number, stated that they agree that school staff has good knowledge of the content of STEM subjects, while another 6 respondents strongly agreed. Seven participants had a neutral opinion on this, neither they agreed nor disagreed. However, five participants disagreed with the idea that staff are well equipped with knowledge on STEM subjects and two strongly disagreed.

Regarding the use of mixed methods in STEM education, 12 respondents claimed that they agree on the fact that such methods are used at schools in Cyprus and two respondents strongly agreed. Most responses, 13, were neutral while there were also some respondents, 6, who disagreed supporting that mixed methods are not used.

7.8 Experience with STEM education

Participants were asked to express their experience with STEM education by choosing as many of the options provided as relevant. The majority of respondents (48.4%) mentioned that they had completed lessons or workshops in their field of expertise at school. 13 participants had taken place in conferences on national or international level on STEM education. 9 respondents said that they had completed some course or certification on STEM education. 9 respondents mentioned some networking opportunity with STEM educators from other schools and 5 respondents had been involved in some research opportunity relevant to STEM education. Finally, only one respondent had participants in some school trip to another school as an educational STEM-related activity.



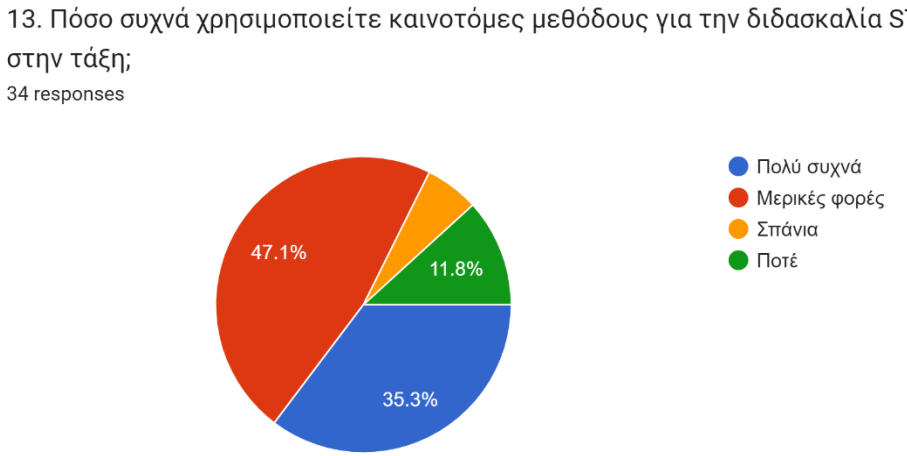
7.9 Innovating teaching methods in STEM

The majority of respondents (74%) claimed that they use innovative methods to enhance STEM learning for students. However, 20.6% of the respondents, that is 7 educators, claimed to not use such methods when teaching.

Some of the 27 respondents who claimed to use mixed and innovative methods in teaching gave examples of the methods used. The majority stated that they use problem-based learning and project-based learning, that is presenting a problem that needs to be solved by students or assigning a project to individual or group students to work on. One respondent explained that they have a group work every two weeks, where participants are grouped together in groups of

3 or four students and after completing their assignment, they have to present their results and outcomes in class in an attempt to work on their public skills.

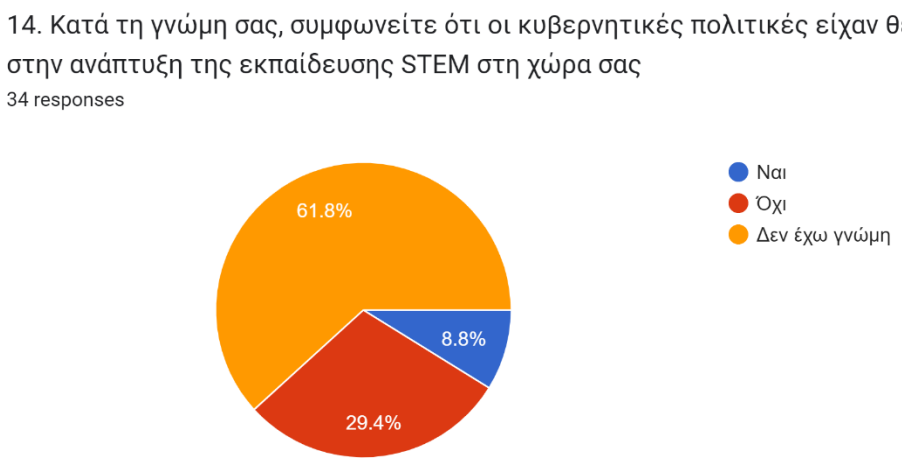
Other examples were experiments and inquiry-based learning to detect theories, principles and solutions to problems. Group work was at the core of most respondents as well as mentioning examples from real life. Educational robotics were also mentioned by one respondent. Further ideas includes storytelling, video creatio, challenge-based and design-based learning. One respondent gave more specific examples such as Makerspaces, Fab Labs, STEM and Living Labs.



Regarding the frequency of innovative methods in teaching, the majority of participants (47.1%) stated that they use them ‘sometimes’ while the second most prevalent response was ‘very often’ at 35.3%. Just two respondents answered ‘rarely’ but interestingly 5 respondents answered ‘never’.

7.10 Educational polices and their impact on STEM education in Cyprus

Paritipants were also asked to express their views on the impact that educational policies have on STEM education in Cyprus. The majority of respondents, 21 in number (61.8%), answered ‘No opinion’. 10 respondents answered negatively while only 3 out of 34 respondents stated that policies benefit STEM education.



When asked to expand on their views, 2 participants stated that they are not aware of any policies that benefit STEM education in Cyprus, 1 respondent mentioned not knowing any seminar or action by educators on STEM, and 1 participant said that they do not consider any significant and substantial development of STEM education policies in Cyprus. Three respondents highlighted that there is a very extensive syllabus and assessment system in STEM subjects, particularly in High School, which causes limitations to teachers in enhancing STEM education especially due to pressure to cover syllabus and time restrictions. One participant stated that their opinion on educational policies was rather mixed since the need for educational policies emerged from students' grades, European and international circumstances especially due to economy, yet in applying mixed methods and introducing educational policies there are significant restrictions due to limited time, syllabi, and limited equipment in secondary schools.

7.11 Further comments and suggestions for the future by educators

When asked to add further comments or recommendations for the improvement of STEM education in Cyprus, 8 respondents stated that there is more need for teacher development in order to employ innovative mixed or interdisciplinary teaching methods. One respondent stated that colleagues also use mixed methods of teaching and there have recently been seminars and initiatives organized in the field of STEM, however the majority were not aware of such training activities and mentioned their importance and need to be made available for educators. Some participants mentioned 'Train the Trainer' opportunities and seminars or asynchronous courses. It was mentioned again that educators are in need of learning how to use mixed and

interdisciplinary methods in STEM education as well as ways of changing educators' 'mindset' and perspective towards learning in order to deviate from traditional techniques used for years and better implement new teaching methods. As part of training, one respondent suggested having lesson plans related to the syllabus.

Two respondents mentioned the need for correct equipment that can be used for such teaching methods to work effectively. One respondent explained that if computers worked properly in all classes, they could have used them for group work and assignments with computer use more but at the moment it is not feasible.

Some respondents stated that another inhibitory factor is the lack of time. Some respondents further stated that STEM education is mainly used in primary education, but it is often neglected in secondary education as there is a significant need to cover syllabus for STEM subjects, which inhibits them from using more interactive, creative and mixed methods. Robotics was mentioned as a point of interest but again, mainly in primary and pre-primary education. It was mentioned by 3 respondents that it has recently received significant interest among young learners in Cyprus.

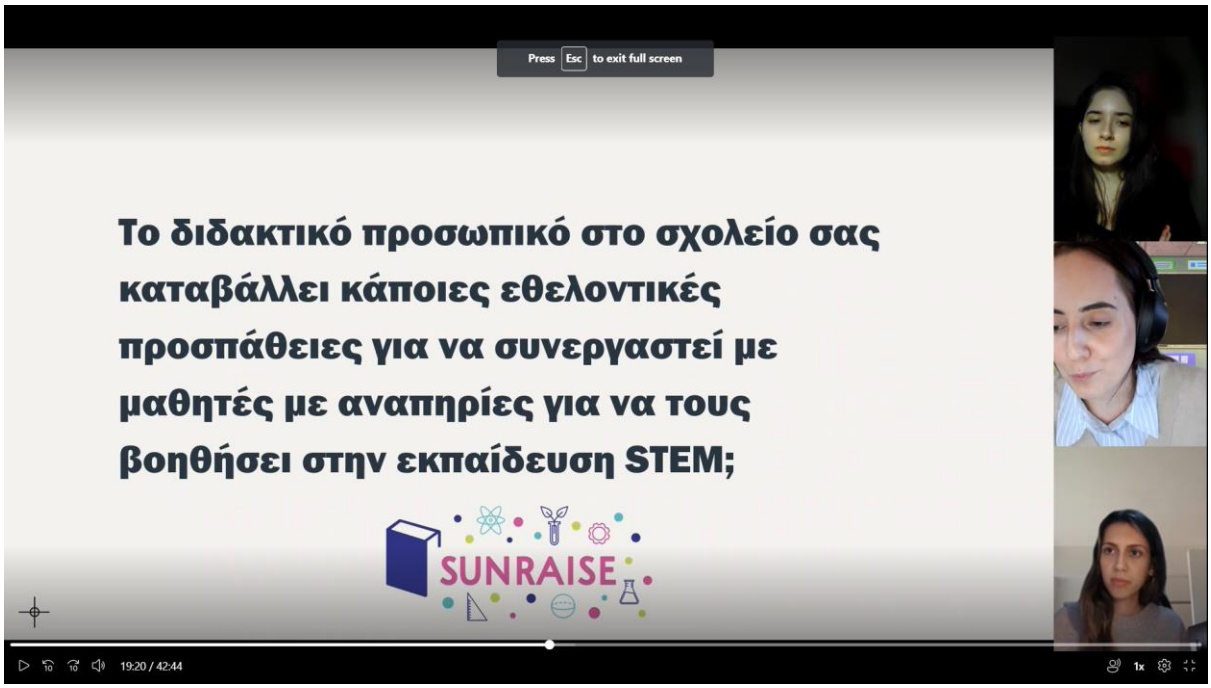
When it comes to syllabi, one respondent stated that if there was less syllabus there would consequently more time and flexibility for educators to experiment with new learning techniques but as long as there is a lot of pressure to catch up with tests and exams, there is limited time for projects.

8. FOCUS GROUPS

8.1 Participants

In total over 60 educators were invited to focus groups that were schedules to take place over two different dates, with 6 alternative dates and times made available for participants to choose, yet only 2 participants were finally able to attend the focus group due to time restrictions and busy teaching schedules in October-November 2022. In the end, two educators who were

employed also as project managers in private educational companies attended the focus group that was administered online via Teams on 25/11/2022.



After explaining the purposes of the focus group and granting consent by participants, we started discussing following some questions decided by the consortium.

8.2 Important STEM skills

One participant referred to the guidelines by UNESCO, saying that critical thinking is a very important skill. It was later added that creativity is equally important because it allows learners to adjust in different contexts making use of the resources they have. The second participant referred to problem solving and agreed on resourcefulness and adjustment as the first participant. They both agreed that there is a range of important STEM skills yet the aforementioned ones were the most important that they could come up.

The importance of STEM in schools in Cyprus generally, was mentioned as something 'theoretical' by the two participants. They both shared that perhaps educators might get too caught up with completing their lessons, using the material they have instead of remembering the big question that needs to be answered throughout the lesson and the skills that are expected to be developed. One participant stated that often there is a lot of pressure in students overachieving in STEM subjects since the subjects are often seen as the most important in succeeding in the future, which is often accompanied by traditional techniques instead of being

seen as subjects that can be used to develop the skills mentioned as core in STEM learning previously.

8.3 STEM Education in schools in Cyprus

When it comes to the teaching methods used for STEM education, one participant mentioned games. She stated that games are used in all age groups, from kindergarten ages to adults who themselves are educators even at tertiary level. Robotics was mentioned as a method that it is indeed very widespread in Cyprus and used lately yet it was mentioned by one participant that in many cases it works as an umbrella term in Cyprus and the aspect of coding, which is considered pivotal in robotics, is often 'forgotten'. However, it was stated that robotics is indeed very useful in developing problem solving skills since it makes learners use their brain in order to think of a solution to a problem.

One participant stated that many educators use STEM education without being fully aware of it, or without knowing the term exactly. It was mentioned that the way teachers in primary and secondary education ask questions often helps the development of STEM skills even if the 'label STEM is not used'.

8.4 Techniques used in STEM education

One participant stated that she follows STREAM method which uses Reading and Arts. She said that it is very important for educators to understand that everything is connects, for example create a pyramid with pasta which can help one teach from history to mathematics. Putting pieces of together will result in breaking apart and reflecting on their actions. Such activities can develop reflective thoughts, action planning and problem-solving skills. It was highlighted again that games are very important in teaching STEM.

It was mentioned that using gamified learning and STEM techniques is not harder for secondary education, but it is more time consuming and challenging in secondary education because of the limited time and large syllabus for STEM subjects. Both participants agreed that the creativity and gamification of learning goes away in higher levels of education and often distinguish arts and STEM subjects, neglecting the importance of creativity when learning STEM subjects.

When asked about freedom to incorporate innovative methods for better STEM education, participants mentioned that educators are the 'leaders of their classroom' so regardless of

restrictions that relate to time and syllabus, all educators can make even small changes by adding certain innovative activities. One participant mentioned that some learners had been reluctant to new innovative methods. In order to avoid this, the participant suggested having more support by school leaders and perhaps reducing the extensive syllabus in STEM subjects.

One idea of STEM learning suggested by one participant was flipped classroom. She stated that instead of reading out from books and delivering the material in the mode of a lecture, students will be sent home with some videos to watch, which they can watch as many times as they wish, and then during in-classroom time there is room for discussion and more interactive activities.

8.5 Learners with disabilities and other marginalized groups

One participant said that in Cyprus many refugee students and students with disabilities and learning difficulties do not have access to the same opportunities as other students. Both participants agreed on the fact that students with significant learning and/or cognitive difficulties do not have any significant support at schools, but they have an educational 'accompanist'. Neither could remember the exact term used at schools but agreed that it is an educator who teaches the student on a private basis when the rest of the classroom has a lesson, but without following any particularly different learning techniques or having any specialized equipment. It was agreed that based on participants' knowledge, the accompanist's responsibility is to repeat the content of the lesson in the same way already taught in class. One participant said that she has overseen students with sever learning difficulties and reported significant demotivation and negative emotions experienced by students due to feeling 'weak'. Creative STEM education supported such students, improved its confidence and resulted in better learning outcomes.

The second participant mentioned the existence of 'special' schools such as _, but mentioned that in general public schools they are often neglected. A suggestion made for their integration I the classroom is the *adjustment* of lesson plans and learning material to their needs for better support.

8.6 Incorporation of arts in STEM education

One participant mentioned the use of storytelling and role playing in teaching STEM subjects but did not have any experience implementing such methods.

The other participant expressed her experience in using music during lessons through reenactment, for example through themes such as Jurassic Park. Another idea used which was also suggested for SUNRAISE is a 3D hologram.

When it comes to their views on this incorporation and the attitudes of students, both participants agreed that the teacher's role is crucial. It was stated that the method does not need to be labelled but the educator needs to be well-prepared and organized while promoting such new activities. The other participant expressed some possible reluctance by students but with clarifications that such incorporations do not render 'games' then they could be interesting and effective. The conclusion made was that the approach of the teacher is crucial in incorporating Arts in STEM education.

When asked about good practices in STEM education with the incorporation of arts, neither participant was aware of any such practices to share. One suggestion added was that the winner of 2018 Global Teacher Prize, Andria Zafirakou who is of Cypriot Heritage, teaches art and might have an interesting bibliography that can help with the design of our mdules.

8.7 Recommendations and suggestions for the inclusion of arts in STEM/STEAM

One participant bolded the importance of reenactments and role play. It was suggested to create a gamified classroom that includes role play where students are given a role to play.

9. Conclusions

Overall, educators that took part in either the surveys or focus groups for SUNRAISE, highlighted the need for more training to educators and the importance of enhancing STEM education in schools in Cyprus as its importance remains vital for the development of independent, competent young people who can provide technological and scientific solutions.