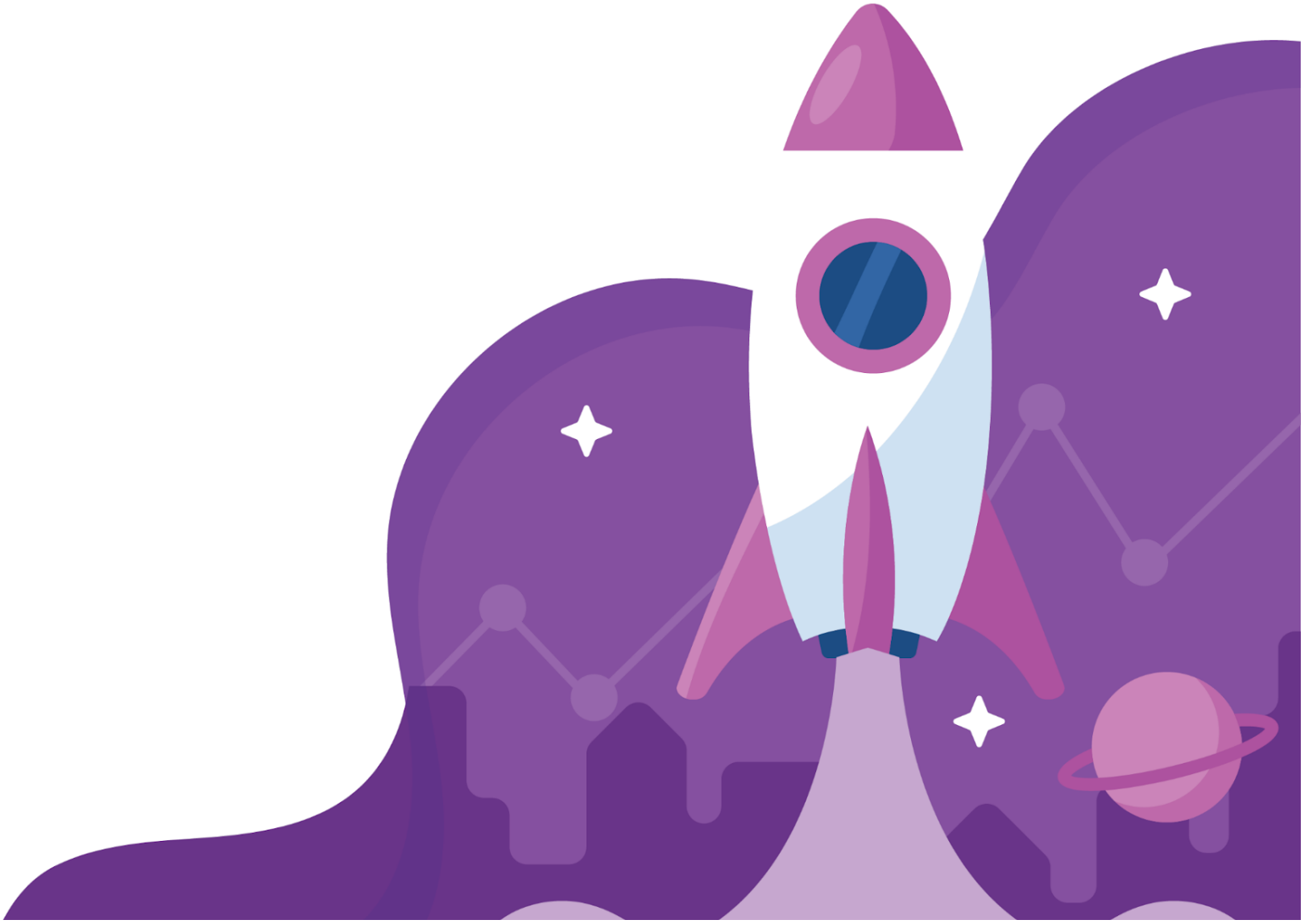
STEAMitUP Policy Recommendation Report

Project Number: ***2019-1-UK01-KA201-061990***

Erasmus+



Lancaster & Morecambe College

Fundación Siglo 22

fip Future In Perspective

DOUKAS SCHOOL 1917

CARDET

university of groningen

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Executive Summary

The report summarises the findings of the focus groups that took place in the 6 partner-countries. These are organized around the main five steering questions: a) project examples and relevant experiences; b) views of STEAM and its value; c) challenges related to STEAM approaches; d) required support for implementing STEAM approaches; and, e) policy recommendations. Overall, the findings across the 6 focus groups, despite the contextual particularities and cultural differences, are consistent and can be summarized as follows. In terms of examples of projects and experiences, all participants were able to share specific projects and shared experiences with STEAM projects mostly at higher levels of education than primary levels of education, such as primary and secondary school. Collectively, all participants shared positive views and were able to discuss the value of an integrated approach to science teaching that brings together not only STEM disciplines but also the Arts. Based on the shared experiences, it is apparent that the Arts typically serve a supporting role in STEM teaching. In terms of challenges related to STEAM approaches, two stood out across the focus groups: a) the need for teachers' professional development especially in developing the skills and knowledge needed to use contemporary technology applications (e.g., robotics, virtual reality); b) access to resources both in terms of curricular as well as technology equipment and tools. These challenges are intertwined with the desired support for implementing STEAM approaches, as across the focus groups the participants shared the need for access to readily available curricular materials as well as technology tools.

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In terms of policy recommendations four main themes emerged: a) promoting out-of-school STEAM practices and collaborations with school; b) budget availability for STEAM approaches to teaching; c) advocating for the value of an integrated and interdisciplinary approach; and, d) promoting partnerships between public education and the industry sectors.

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Overview and Methodology

Focus Group Topics & Directional Questions

1. **Share one key example of a STEAM projects which they were involved**
    1. Why is this a key example?
    2. How was the project implemented?
    3. What made the project interdisciplinary?
2. **Share experiences**
    1. What was in your eyes successful about the project?
    2. Is there something you would change in hindsight?
    3. How will you build on this experience?
3. **Views about the value of STEAM approaches**
    1. What makes STEAM education in your eyes valuable?
    2. Why is an interdisciplinary approach valuable?
    3. How should art be integrated in STEM education?
4. **Challenges they face and support needed**
    1. Identify the 5 most important challenges for you regarding STEAM education?
    2. What are possible solutions to these challenges?
    3. What kind of support would you like to receive from your: Colleagues, School / organization, Local district / Government

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Look into the future: recommendations for policy

a) Should STEAM education be integrated into school curriculum? If so, how?

b) Does any current policy need to change in order to support STEAM education?

c) What can we learn from (inter)national examples?

Focus Group Guidance

Structure

Focus groups are structured around a set of carefully predetermined questions – usually no more than 10 – but the discussion is free-flowing. Ideally, participant comments will stimulate and influence the thinking and sharing of others. Some people even find themselves changing their thoughts and opinions during the focus group.

A focus group is *not*:

- A debate
- Group therapy
- A conflict resolution session
- A problem-solving session
- An opportunity to collaborate
- A promotional opportunity
- An educational session

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How to pose questions

Focus group participants won't have a chance to see the questions they are being asked. So, to make sure they understand and can fully respond to the questions posed, questions should be:

- Short and to the point
- Focused on one dimension each
- Unambiguously worded
- Open-ended or sentence completion types
- Non-threatening or embarrassing
- Worded in a way that they cannot be answered with a simple "yes" or "no" answer (use "why" and "how" instead)

Three types of questions

There are three types of focus group questions:

1. Engagement questions: introduce participants to and make them comfortable with the topic of discussion (5-7 minutes)
2. Exploration questions: get to the meat of the discussion
3. Exit question: check to see if anything was missed in the discussion (5 minutes)

Moderating team

Ideally, the focus group is conducted by a team consisting of a moderator and an assistant moderator. The moderator facilitates the discussion; the assistant takes notes and records the sessions.

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The ideal focus group moderator has the following traits:

- Can listen attentively with sensitivity and empathy
- Is able to listen and think at the same time
- Believes that all group participants have something to offer no matter what their education, experience, or background
- Has adequate knowledge of the topic
- Can keep personal views and ego out of the facilitation
- Is someone the group can relate to but also give authority to
- Can appropriately manage challenging group dynamics

The assistant moderator must be able to do the following:

- Record the session
- Take notes
- Note/record body language or other subtle but relevant clues
- Allow the moderator to do all the talking during the group

A moderator must tactfully deal with participants, here are some appropriate strategies:

- Self-appointed experts: “Thank you. What do other people think?”
- The dominator: “Let’s have some other comments.”
- The rambler: Stop eye contact; look at your watch; jump in at their inhale.
- The shy participant: Make eye contact; call on them; smile at them.
- The participant who talks very quietly: Ask them to repeat their response more loudly.

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Results and Outcomes of Focus Groups and Policy Recommendations

1. Project examples and relevant experience

In terms of examples of projects and experiences, all participants were able to share specific projects and shared experiences with STEAM projects mostly at higher levels of education than lower levels of education, such as primary and secondary school. For this report, we choose to highlight an example from Cyprus, which serves as a representative project that implements effectively an integrated and interdisciplinary approach to science teaching.

STEM summer school for girls. It was a 4 days program in which 20 girls participated in interactive activities with an emphasis on understanding the role of women in science, developing STEM skills and entrepreneurial skills. The combination of practices and the team of people who worked together to set it up thus tight this up into an interdisciplinary project.

The IN2STEAM project aims to enhance, encourage and foster innovative educational approach that integrates STE(A)M learning (applying art and design principles to science education) in primary education through gender-inclusive methods and resources to promote a positive change of attitudes towards non–stereotyping choices in education in order to attract more girls into STEM fields. In the context of the project, partners developed a MOOC course for the teachers that included both theoretical and practical knowledge. Currently, teachers are in the process of organizing STEAM labs with students."

"The students worked at stations with the Pro – Bot in order to program various missions. The students worked using the programming software A. L. E. X. to fulfill the missions. Finally, students work on the computer, using the website www. code. org, to program their hero to go through all the stages.

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2. Views of STEAM and its value

The consensus overall was that many focus group participants as well as many of the students they have previously worked with value STEAM for a variety of different reasons. One recurring benefit being mentioned was the multidisciplinary approach of STEAM and the real and practical benefits this has for some students. This multidisciplinary allows for a wider range of employment possibilities according to the experience of some focus group participants. Furthermore, one of the most often mentioned benefit of a STEAM education is how broad ranging it is, how diverse the information learned is, and the interdisciplinary approach makes it easier for students to relate the subjects with each other and have a better overall understanding of each field of study. There were also some additional comments made by a few participants, such as the economic value STEAM could have if future generations were STEAM-educated, as well as how this could also affect the innovation and technology in a country in the long-term. There are indeed many different and unexpected ways in which STEAM is valuable for different people. In the future, many employment opportunities will require interdisciplinary work, and having a STEAM education sets one up for this much more so than a traditional education which is less diverse and wide-ranging. Many of the focus group participants looked at STEAM education as something that would be commonplace in the future, and effect many sectors (economic, technological).

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3. Challenges for STEAM

This part of the focus group was the most deeply contested and discussed, with many of the participants having some thoughts to share, more so than any other section of the focus groups. There are a few main categories to divide the types of challenges that are facing STEAM education and the successful implementation of STEAM projects. These can mainly be divided into availability of resources, lack of expertise and knowledge and lack of support from their local environments. These issues can further be divided, however let us take some examples here to exemplify the types of challenges. STEAM is multidisciplinary and requires a broad range of information to be able to properly explain it to students, therefore without specific knowledge or prior training it will be difficult for a teacher to fully expand on the STEAM subject matter or project. This can be attributed to a lack of knowledge on the part of the teacher, but also on the lack of supporting materials for the teacher.

Many STEAM projects utilize newer technologies such as robotics kits or computer programming, which not many teachers may be knowledgeable about or even familiar with. For this reason, such teaching materials are not utilized to their fullest because of a lack of familiarity on the teachers' part. This point was brought up multiple times during the focus groups, and many participants suggested giving teachers some time before a project to play around with new technologies and familiarize themselves with it, so they may be able to properly explain to students how to best utilize the materials and make more efficient use of their time.

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This not only helps students feel less confused by a new project, but also gives the teacher confidence to teach their students, which was another challenge that was brought up. A lack of knowledge utilizing new technologies leading to a lack of confidence in teachers which do not specialize in science teaching STEAM. Overall, teacher training was one of the most ubiquitously discussed topics throughout the multiple focus groups as one of the main challenges facing STEAM projects.

Further expanding on lack of resources, this can relate to anything from not having up-to-date textbooks and computers which can run certain programs to not having a budget for visiting local science exhibitions or museums. One participant mentioned that although there are numerous science exhibitions and museums in the local surroundings, it is very difficult to visit these destinations as the financial burden would be placed solely on the teacher, as there is no appointed budget specifically for these sorts of trips. Furthermore, compared to sports or arts, STEAM subjects do not have an after-school equivalent. You can practice soccer or do sketching in a specific location after school closes, but there is no such place for STEAM yet, making it more difficult to be as involved with STEAM, adding a further barrier to successful implementation of STEAM projects or education. This point relates to a lack of a STEAM-oriented space or platform, which restricts the reach that STEAM can have outside of school as well as how much it is discussed and thought about.

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4. What support is required for STEAM implementation to be successful

The support recommended by many of the focus group participants directly related to the previous section and therefore many of them relate to the most common issues brought up by the different focus groups. The lack of materials such as textbooks, robotics kits and expensive software can be dealt with quite directly. That is, by increasing the funding available for these materials or the funding accessible to STEAM projects, so that a budget is already attributed to STEAM projects. Specially allocated budgets for specific STEAM-related areas would be of great help to many teachers trying to implement STEAM projects. For instance, having a dedicated budget would allow teachers to visit more of their local destinations – such as workshops, museums and exhibitions - all of which can contribute towards a students' understanding of STEAM and therefore the potential successful implementation of it. Given that STEAM encompasses more than 5 broad subjects, having access to more resources to better understand the practical and interdisciplinary aspects of STEAM education can be very beneficial to students and the future of STEAM education.

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Having the support of the school management is something that was also mentioned multiple times during the focus groups, as this is a specific type of support for teachers which has many more implications. By having the support of management, there are many roadblocks which are removed, such as issues related to space, budget or location issues. This could also help with another very pertinent point – namely the training and education of teachers prior to a STEAM project.

With the support of school management and teachers, training sessions can be scheduled, rooms can be set aside for practice and time can be allocated to allow teachers the time and space to familiarize themselves with either new technologies, tools and kits or new knowledge and information which is needed to understand and explain the interdisciplinary and practical nature of STEAM to students which are not familiar with it. One must not forget that some teachers as well as students find STEAM overwhelming at first due to it involving new technology or information from fields one has never studied before. Therefore, allowing teachers to become more confident and proficient in these topics beforehand will enable them to pass down this information and knowledge confidently to the students, allowing them to hopefully avoid some mistakes and misunderstandings ahead of time, and further stoking curiosity for STEAM projects and education.

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5. Recommendations for Policy that would help STEAM

Policy addressing extra-curricular STEAM

This type of policy is needed to encourage students which have an interest in STEAM and draw in those who may have an interest. Having a space where one can go to find information, speak to other similar-minded students or even a space to practice some of the STEAM-related topics such as certain computer programs or interdisciplinary papers are sorely lacking. Without a stage for STEAM outside of schools, the interest and involvement in STEAM from the community will not change. Rather, by implementing such spaces and reaching out to local communities, more people will become aware of STEAM, extending its area of influence which could prove beneficial in future implementation and adoption of STEAM-oriented educational policies.

Policy addressing centralized STEAM budget and the development of a database

There are many schools, institutions and workshops throughout different countries which have tried to or successfully implemented STEAM projects in the past, and there is no place to access the information gained from all those projects. Mentioned in the focus groups was a need for centralizing this information to make it accessible to everyone, so that they can learn from those past STEAM projects when looking to implement projects in the future. By understanding the approach one tool and why it failed or succeeded, making future projects a lot easier to work around and can ensure certain mistakes will not be repeated.

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Currently (within the Netherlands at least) there is no way for these institutions to share information as there is no place information is being stored related to STEAM projects or education, therefore the creation of such a platform was of paramount importance according to the focus group. Sharing information to better understand which faults to avoid, and the successes to replicate would help tremendously according to the focus group participants.

Policy partnering education, NGOs, and industry:

A summary of the findings across the focus groups showcases the need for having a practical basis of the information and knowledge presented to students will help prepare them for the workforce and ground their information in reality. This can be achieved through partnerships between education providers, NGOs and the industry sector as a way of providing tools, mechanisms, and strategies for broad collaborations between schools and different representatives of society.

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Partner National Reports

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National Report (Cyprus) – 15th November, 2021

Identity of the Focus Group

On Monday November 15th, 2021, CARDET representatives held an online focus group session with 8 participants and two moderators. The focus group sample was recruited from public primary schools in Cyprus. The sample of the study consists of in-service teachers working in different schools across four regions. Participants were invited to participate via a post which was uploaded on a social network page dedicated to Primary school teachers who work at the Republic of Cyprus (South Cyprus). Those who expressed their interest to participate in the online focus group received a follow up email with additional information for the implementation of the session (location, date, time). These seven participants brought in different identities related to STEAM knowledge and expertise, from School Principles, Academics, and Researchers up to in-service teachers. This equipped us with a wide selection of relevant topics and policy recommendations from the local to the regional levels. The online session was hosted by the Google Meet system. The facilitators launched the online focus group to support attendees' schedule and needs during the evolving pandemic. The focus group session was formed according to the guidelines prepared by the coordinator of IO4, RUG in Netherlands. The online session was facilitated by two CARDET members; one who facilitated the discussion and taking notes during the online discussion; and one involved in the analysis and reporting of the recording to ensure notes, transcripts and translations are well-presented. The online session was conducted at 18h00 and lasted approximately 1 hour and 30 minutes.

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The facilitator welcomed the participants and thanked them them for accepting the invitation to participate in the study. In addition, the facilitator introduced the teacher colleagues to set the basis for a productive discussion to follow. An overview of the STEAMitUP project was first put into place, followed by the objectives of the focus group session. Focus group guidelines were explained to the interviewees' by guiding the group through the research questions which were included in the guide sent by RUG. The session run smoothly, and a friendly environment accompanied the interesting topics discussed, the opinions raised, and the experiences shared by each teacher participant. The only barrier encountered was the irregularity of the internet connection.

Structure of the report

The report is organized into four sections to provide insights into the needs and recommendations for STEM-related policy actions. These thematic areas emerged through the interview guide and the results obtained from the focus groups on STEAM education. It concludes by highlighting key aspects emerged from this national focus group work with key STEM experts Action Plan will concentrate on guidelines and recommendations in the following areas.

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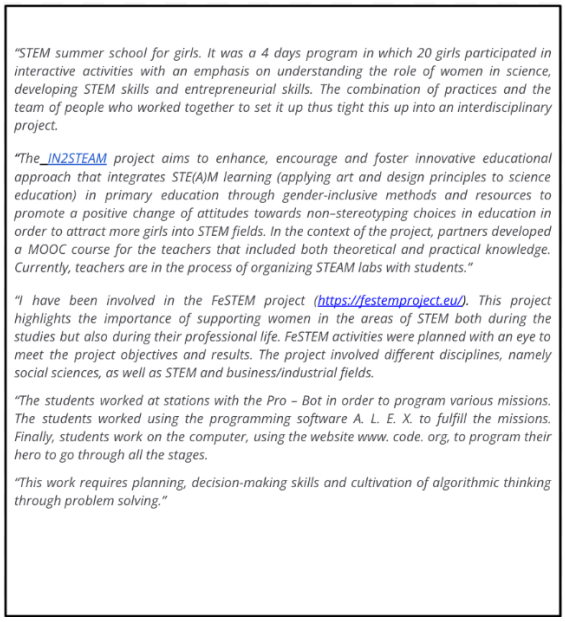
Thematic Area 1. Project Examples and Experiences in STEAM related topics

The focus group began with sharing past experiences related to STEAM projects including any relevant projects that are considered notable learning examples. Most of the participants shared their experience on specific STEAM projects and how these projects were proven to be interdisciplinary, as well as the benefits associated with them. It was of note how technically advanced projects were for primary school children, involving robotics kits and some programming. Furthermore, all the example projects mentioned already incorporated Art into STEM in unexpected ways (design their own plant and use a bee bot to design a maze), and all of these were projects for primary school students. The learning objectives and outcomes were also shared by the focus group participants to emphasize what worked well and what didn't.



"STEM summer school for girls. It was a 4 days program in which 20 girls participated in interactive activities with an emphasis on understanding the role of women in science, developing STEM skills and entrepreneurial skills. The combination of practices and the team of people who worked together to set it up thus tight this up into an interdisciplinary project.

"The IN2STEAM project aims to enhance, encourage and foster innovative educational approach that integrates STE(A)M learning (applying art and design principles to science education) in primary education through gender-inclusive methods and resources to promote a positive change of attitudes towards non-stereotyping choices in education in order to attract more girls into STEM fields. In the context of the project, partners developed a MOOC course for the teachers that included both theoretical and practical knowledge. Currently, teachers are in the process of organizing STEAM labs with students."

"I have been involved in the FeSTEM project (https://festemproject.eu/). This project highlights the importance of supporting women in the areas of STEM both during the studies but also during their professional life. FeSTEM activities were planned with an eye to meet the project objectives and results. The project involved different disciplines, namely social sciences, as well as STEM and business/industrial fields.

"The students worked at stations with the Pro – Bot in order to program various missions. The students worked using the programming software A. L. E. X. to fulfill the missions. Finally, students work on the computer, using the website www. code. org, to program their hero to go through all the stages.

"This work requires planning, decision-making skills and cultivation of algorithmic thinking through problem solving."

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Thematic Area 2. Views about the value of STEAM approaches

Participants were then asked to offer their views on the value of STEAM approaches. This question was driven by 3 main sub-sections as follows:

a. What makes STEAM education in your eyes valuable?

b. Why is an interdisciplinary approach valuable?

c. How should art be integrated in STEM education?

The below statements declare most of the participants' position in favor of the importance of the interdisciplinarity approach. Besides, they provide insights on how arts could be integrated into STEAM education. Some examples are given below:

"The interdisciplinary perspective and the hands-on approach that can help students develop various 21st century skills. Because it resembles to everyday life skills and will prepare students for their active role in the society and workforce. In our project art was the means that was used for the students to create their outcomes. I am not sure in which other ways art can be integrated but I would like to learn more."

"The STEAM education promotes creativity, problem-solving, decision-making, communication, skills that are required in today's innovation-driven economy. This framework connects students' education to real-world problems enabling them to observe interlinkages between different thematic areas (e.g. how maths are connected with Art etc.). Art could be integrated in STEM education through the design and development of ideas and the implementation of projects. Technology provides new opportunities to learn Art concepts."

"STEAM is important especially for supporting a holistic, interdisciplinary approach that cultivates 21st century skills. Interdisciplinarity is important for preparing our students for future career opportunities. More specifically, it enables our students to become creative thinkers, problem solvers, to be innovative and combine different disciplines to find innovative solutions to big problems. How should art be integrated in STEM education? Arts can illuminate the field of STEM by integrating strategies or creativity for finding innovative solutions for STEM."

"By acquiring knowledge and skills from various fields, students can understand multiple perspectives of the same subject, thus being able to solve complex problems. Art can be incorporated in several ways: By designing the constructions they will develop or through their artistic creations they can create an innovative thought or idea."

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Thematic Area 3. Challenges and further support regarding STEAM education

Generally, challenges are related to ack of trained staff, lack of resources, school policies, strict school curriculum, lack of planning. More precisely, participants exemplified the need for teachers' training to clarify the difference between STEAM and robotics, thus be able to integrate authentic STEAM-related approaches into the classroom settings. Structured school curricula on topics per course e.g. Maths, Science, Arts do not give space for teacher flexibility to interact between and within topics. This is the case across different levels of education from primary, secondary up to higher education. The key challenges, included but are not limited, are following:

- Teachers' professional development
- Changes in the curriculum (including university curriculum) to make it more flexible for interaction between disciplines
- Restrictive school curriculum
- Absence of structured professional development courses for teachers
- Lack of technological equipment in schools
- Additional personal time is required to organise STEAM activities
- Evaluation system (e.g. how to assess students' progress)

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To tackle all these challenges, STEAM education needs to be integrated in the school curriculum and the government has to provide the necessary support to the teachers. Number one solution to the aforesaid challenge is teachers' professional development and training on these topics. Other ideas which were suggested by the participants are:

- Linking topics to real life
- Create an online repository of OERs' that support teachers to integrate STEM activities across different age groups. Participation of all students regardless of performance or abilities.
- Solving realistic problems
- Importance of the subjects taught
- Use of modern technology to make students active in the learning process
- Review of literature on the topics
- Suitable Equipment
- Smaller group of students, assistant instructor in the classroom
- Ability to work with colleagues in a more flexible way
- Formally introduce STEM in the curriculum but also provide support to teachers
- The local district/ government could draw a plan for the improvement of school curricula and available budget per school

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Thematic Area 4. Policy Recommendations

This section is formed by 3 main questions:

a. Should STEAM education be integrated into school curriculum? If so, how?

b. Does any current policy need to change to support STEAM education?

c. What can we learn from (inter)national examples?

During the focus group session participants indicated some important points to be considered when designing and developing a policy recommendation strategy. A point which was highlighted by most of the interviewees was the fact that education stakeholders need to invest on teacher training. Below is an evidence:

> *"Yes, but teacher training should happen first. Train some teachers and then "use" them as ambassadors whilst at the same time provide sample activities that can be used by teachers. The curriculum should be more flexible. Introducing STEAM in primary or pre-primary is easier because of the flexibility, but this is not the case for the secondary education. Changes in how disciplines are divided should take place. What I have learned is that integrated STEM and STEAM is very difficult, and whenever we have good examples, these should be disseminated with teachers and university instructors."*

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In addition, STEAM education must the integrated into the school curricula. This is justified as follows:

> *"Definitely, STEAM education should be integrated in the school curriculum. To achieve this, a STEAM framework needs to be developed that will serve as the main reference for teachers. At the moment, the schools in Cyprus focus on traditional teaching approaches where the teacher serves as the main source of information providing few or no opportunities for students to take control of their learning. Also, the cultivation of soft skills is not among the school's priorities. Such examples approach learning holistically and align with the needs of the modern society."*
>
> *"Yes. More emphasis should be given in project-based learning and emphasis on projects that would allow for multi/interdisciplinary knowledge."*

As a final note, there are various experiences internationally that could enlighten our future policy making that must be taken into consideration. Please see some indicative key references below:

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Trisno, R., Trisno, F., & Tishani, N. K. (2021). STEAM Elementary School with The Concept of Creative Learning Space in Heidegger's View. *Journal of Design and Built Environment, 21*(2), 38-57.

Trisno, R., Trisno, F., & Tishani, N. K. (2021). STEAM Elementary School with The Concept of Creative Learning Space in Heidegger's View. *Journal of Design and Built Environment, 21*(2), 38-57.

Trisno, R., Trisno, F., & Tishani, N. K. (2021). STEAM Elementary School with The Concept of Creative Learning Space in Heidegger's View. *Journal of Design and Built Environment, 21*(2), 38-57.

Colucci-Gray, L., Trowsdale, J., Cooke, C. F., Davies, R., Burnard, P., & Gray, D. S. (2017). Reviewing the potential and challenges of developing STEAM education through creative pedagogies for 21st learning: how can school curricula be broadened towards a more responsive, dynamic, and inclusive form of education?

Dell'Erba, M. (2019). *Policy Considerations for STEAM Education.* Policy Brief. Education Commission of the States.

Clarke, M. (2019). *STEM to STEAM: Policy and Practice. In the STEAM revolution* (pp. 223-236). Springer, Cham.

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National Report (Greece) – 30th November 2021

Focus Groups for Policy Recommendations

Focus Group Summary

On November 30, 2021, project leaders convened an online focus group. Due to the difficulty in collecting everyone together in person, it was hosted through Microsoft Teams and it lasted slightly more than an hour. There were no technological issues, and the meeting was recorded with the participants' agreement. There were six participants in all, omitting the moderator and assistant moderator. From School Advisors and Professors to researchers and instructors, these six individuals held a wide range of STEAM-related knowledge and skills. As a result, the focus group was able to explore a wide range of pertinent themes and policy suggestions from the local to the regional levels, with both Greek and foreign viewpoints provided.

General Discussion

The focus group began with a general discussion about STEAM. The first statement that was made was that it's not so much about the interdisciplinary approach to the fields (STEAM), but about the philosophy behind them, even though it was originally started to solve real problems (e.g., engineers who did not know how to build a bridge, in the 80s in America) and there was a huge demand for people associated with such jobs. Today, Integrated STEAM is used as an approach, but it is also very restrictive.

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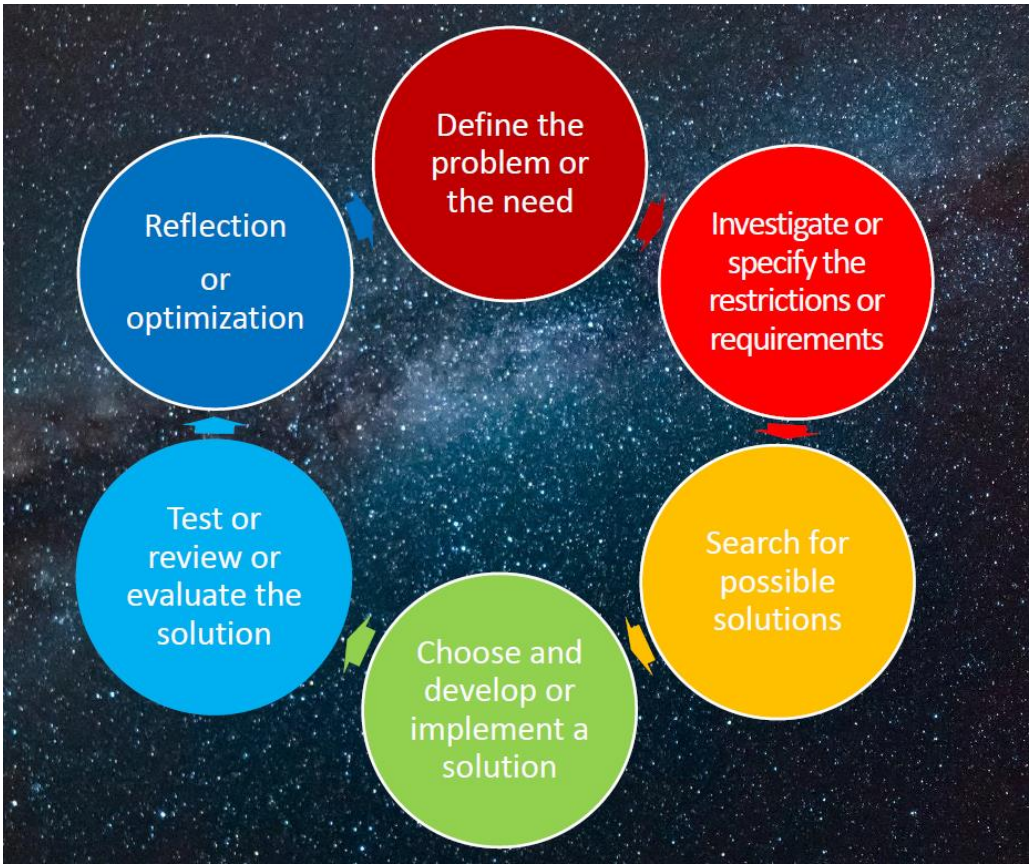
The main component is “E” (Engineering), and it has nothing to do with making robots and constructions, but it has to do with the reasoning of the engineer, that is: design, test, redesign, re-analyze, re-try, until we find the optimal possible solution, not the ideal solution (a solution that works). STEAM is not just robotics, as it has prevailed, and can have an interdisciplinary approach, not just intersectionality. This means that any teacher can develop it with minimal infrastructure and materials within a course in a specific field. Everyone perceives STEAM in their own subjective ways, so everyone can chart their own personal path in terms of this approach.

The “E” (Engineer) Approach



Mikropoulos 2021

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Share key example/experiences of a STEAM project(s) which they were involved

The discussion continued with previous experiences of STEAM projects, as well as any significant projects that provided a beneficial learning experience in the past. Several individuals recounted their experiences with specific STEAM projects, including how they were multidisciplinary, the advantages and how they came out in the end.

A participant mentioned that he tried to create a computer game, pure software, in which remote controlled vehicles and virtual robots run, that is, objects that are operated remotely by students on a track. Each of them had a different programming style and children try to customize and improve it in order to make the game better and more competitive. It is a continuous process of creative thinking, application and production of innovation.

Another participant stated that in the classroom they use mobile phones in many ways and depending on the curriculum of each class they choose either simpler things such as e.g., the measurement of the distance with the distance meter device integrated in mobile phones, combined with the traditional methods of measuring tapes, or more complex activities. For example, in the 2nd High School they measure speed in many different ways via mobile phones, with sensors that measure speed, but also in indirect ways such as time calculation (using a timer) and distance (using a distance meter) and then by dividing those in order to find the Average Speed.

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Also, in the 3rd grade of High School they use mobile phones and tablets to teach the characteristics of sound: They record the speech spectrum of students, they compare the spectrum between boys and girls to study the subjective characteristics of sound, such as tone or height. These things are almost impossible to teach in any other way. They also use tablets to apply augmented reality (AR) so that, based on Physics books, they can relate some phenomena to everyday life and study some physical quantities. This is how they study Dynamic Energy, for instance: they do attempt it in a traditional way, but by using an augmented reality book that brings to life a crane that breaks down a wall. Depending on how high the crane ball is, they adjust its dynamic energy, trying to break down the wall. Also, the children drive virtual spaceships to foreign planets, but also study water's temperature and make diagrams. Finally, they also use Virtual Reality (VR), i.e., students wear masks with free software and make some virtual space travel, getting to know planets and traveling the Universe. These are some of the activities they performed in the classroom.

Another STEAM example a participant was involved in was a subject unit that is related to the recycling of olive oil and the preparation of organic soaps. They realized that if they had to limit themselves to the theoretical coverage of the subject, they would have no chance of gaining the interest of the students. So, they entered the workshop and were teaching the children to recycle the olive oil on their own and make organic soaps. And then they encouraged students to sell the soap and donate the proceeds to a charity.

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Views about the value of STEAM approaches

All participants agreed that students enjoyed themselves during STEAM for so many reasons.

- First, it is a course that is not evaluated and therefore they do not feel pressurised.
- Secondly, they have the opportunity to achieve a collaborative approach to each issue.
- Thirdly, they have the ability to understand why and not just how. In other words, they are actively involved, making their own decisions and are not passive recipients.

One of the participants stated that it is important at the level of general methodology, to understand that we really need to present knowledge to students, despite the differences that may exist from the makeup of the class, the varying levels of the students and the difficulties they face in such a way that:

- knowledge should make personal sense for each student,
- knowledge should correspond to situations through student's experience and real life,
- knowledge should be historically interconnected, and in addition, to provide a perspective

Another point made was that everyone is focused on their scientific field, so there is a problem approaching science holistically. As far as one's abilities are concerned, they need to be brought up-to-date.

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This is a prerequisite. In addition, they should be in the mood to change the way they teach and update their methods. So, the lack of resources does not constitute a major issue, it would rather be the lack of availability for someone to take advantage of all these tools.

A participant added that the digital material, software, or simulations that the teacher may be using are not enough and that the student should visit the laboratory, whether it is a laboratory of Physics, Chemistry, Biology, Technology, Robotics and to be able to produce work. Students perceive the problem, research it and process information, collaborate, communicate, and finally suggest solutions. And the solutions are not just theoretical; they must be applied, first and foremost by themselves. They must therefore learn to operate in the laboratory.

Furthermore, it was reported that many times, teachers try to accomplish and present a lot of projects to their students. But they don't encourage their students to actively participate, and they consider themselves as experts. They need to overcome their teacher-centered approach. Even if they are passionate about something and find it very interesting, this may not gain the attention of their class.

And as far as arts concerned, this was the part where a participant quoted the words of M.C. Escher, who states that after struggling to achieve the technical part of his job, only then matured and was able to make art, describing the transition from STEM to STEAM. So, we have a path (in the dimension of time) that we can start from and then reach the humanities. In general, STEAM approach should be that of "solving a real problem" and this is where "A" (Arts) correlate, because that requires critical and creative thinking, a participant added.

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Challenges they face and support needed

Following that, the conversation switched to the execution of STEAM projects, with many examples provided. This section of the conversation centered on the problems or obstacles associated with executing STEAM initiatives, such as a lack of resources or a lack of knowledge and experience to effectively utilize resources. For example, a point that was reported was that teachers getting involved in STEAM, should have a science degree. Otherwise, it would be extremely difficult for them who have no previous laboratory experience to work in the laboratory.

A participant noted that establishing a STEAM curriculum was really very difficult for him. In order to get ideas and find thematic sections, he read magazines like “Vita” and “The Economist”. He was trying to adapt everyday life to the age of high school kids. He added that, without wanting to ignore the role of other specialties, such as Philologists, Musicians, or Artists, in teaching STEAM, he believes that the approach of science, engineering or mathematics would be difficult for a professor of humanities to cope with. Of course, it would be ideal if teachers of different specialties collaborated. However, this might increase the costs and the operational difficulties.

Participants agreed on that every teacher who gets a ready-made STEAM lesson plan needs training. Since they have not envisioned it and have not created it themselves, it is not easy to implement it. And that’s because the creator has simply adapted it to his/her own skills and data. This view is the result of experience. One’s lessons are not easy for colleagues to

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implement as the creator had designed them. But, if they get the idea and adapt the material to their own capabilities, then the impact on the students can be excellent.

One of the participants emphasized that STEAM is something one should be passionate about. It requires to spend many hours preparing a STEM lesson, before teaching it. The participant mentioned that he needs 6 hours in order to find the idea, to look for the right information, set up his lesson, make worksheets, design laboratory technique and, of course, to rehearse it with his children.

Look into the future: recommendations for policy

This section focuses on what changes may be implemented at government level (from local government to the ministry of education) to facilitate and encourage STEAM projects. The points, on which participants agreed, was that policy should focus on:

- First of all, teachers need support in New Technologies, which is easy to provide by creating Internships and Learning Communities, where someone has the possibility to exchange ideas with others;
- Secondly, it is necessary to provide additional support and try to motivate teachers to apply the acquired knowledge;
- Thirdly, it is important to persuade colleagues to connect their teaching with everyday life. Theories are ok, but students definitely need to apply their learning and gain valuable knowledge.

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A participant noted on the other hand, that policy makers cannot homogenize these things by performing a specific training program. He suggested that teachers at some point must become self-educated and have the opportunity to express their interests and achieve many things. He added that maybe it isn't possible to train teachers in a more holistic way but wondered who could train them in those subjects and what could be the content of such training, since it is very complex and difficult.

Primary education in Greece is not ready to integrate STEAM, as there is anxiety and uncertainty from teachers (because for example, there is no infrastructure for robotics) but ignoring as we said that STEAM is not just robotics. It takes a lot of work and training to teach STEAM since there is no knowledge and infrastructure, according to an additional participant. He concluded that in Greece we do not even have Science, i.e., the first component of STEAM in secondary education (we have not managed to integrate the positive sciences). Basic steps need to be taken before we can discuss STEAM.

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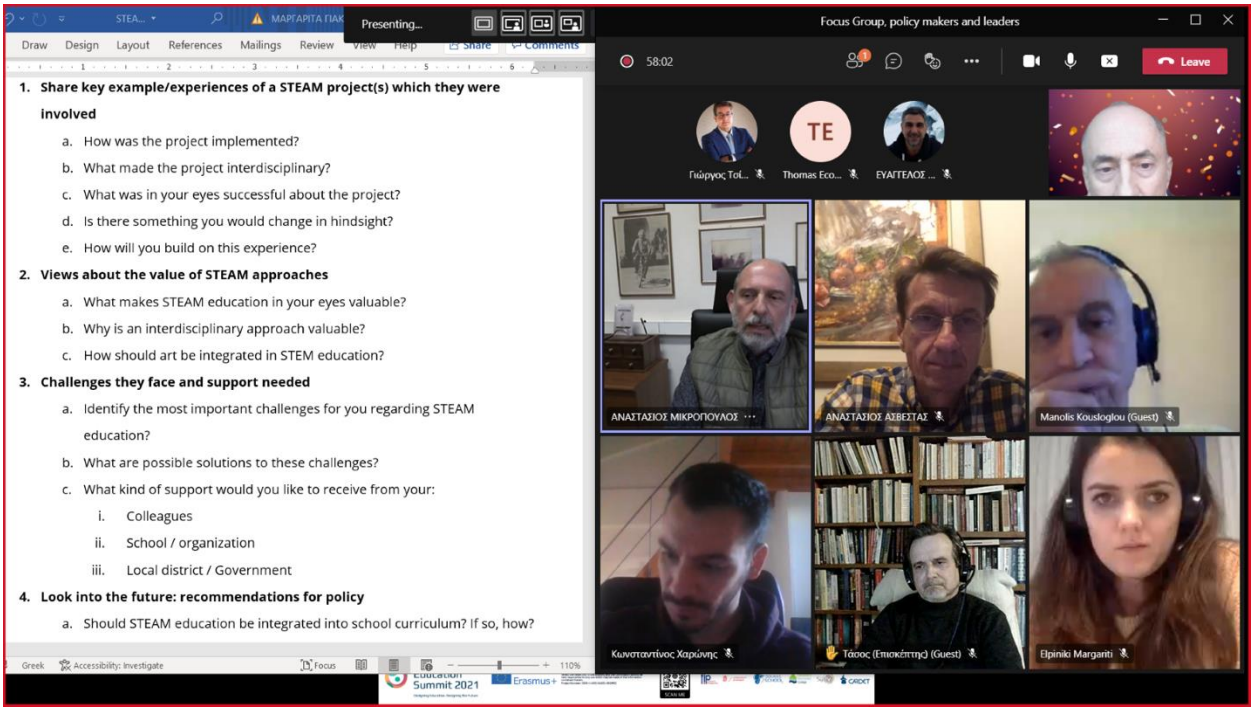

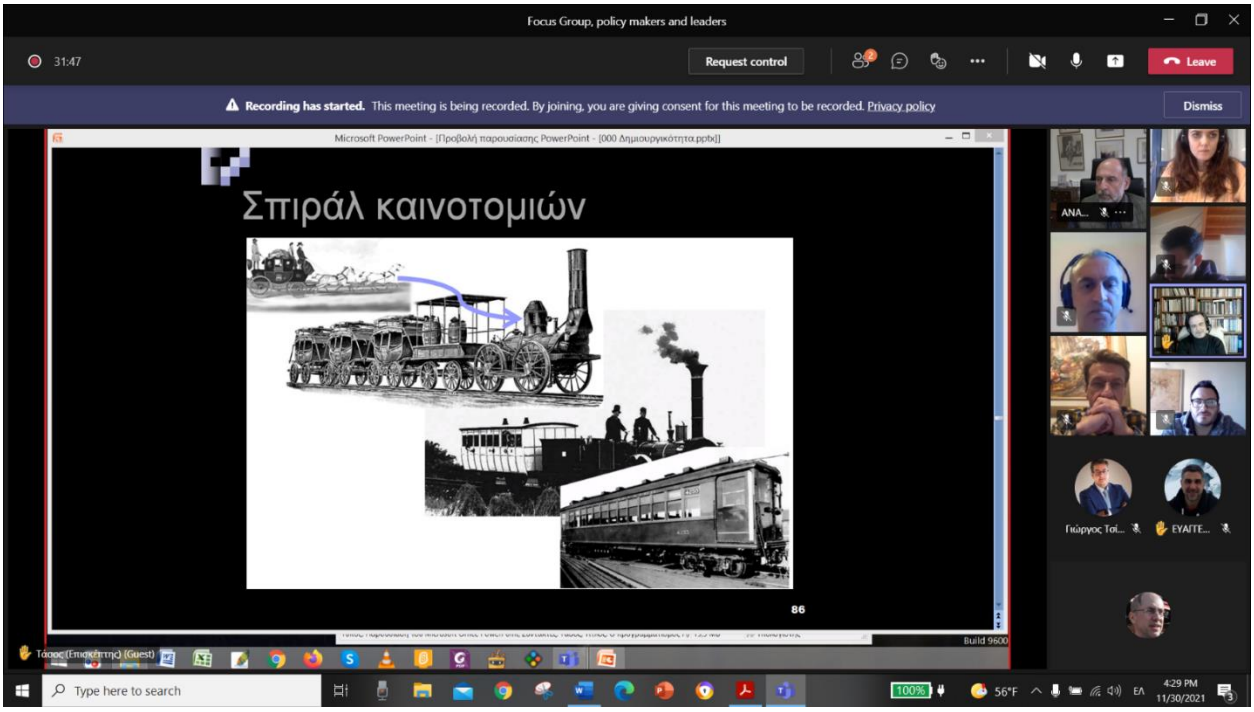

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National Report (UK) – 5th November 2021

Focus Group for Policy Recommendations

Focus Group Summary

The UK focus group took place virtually on 5th November 2021 with six key decision makers representing a selection of local Primary, Secondary and Vocational schools. All participants provided permission for the focus group to be recorded to support the transcribing process. The focus group was hosted by Lancaster and Morecambe College with a member of our STEAMitUP project team facilitating the discussions.

The focus group began with participant introductions then a brief overview of the project rationale, aims and objectives to provide the participants with some context for our work to this point. The participants were then provided with the focus group parameters and an outline of the key discussion points to be covered. The focus group facilitator then guided the participants through the different points of discussion in a structured but open dialogue.

The focus group lasted around two hours and covered all of the key discussion points outlined as well as many additional topics that participants raised which were then discussed in more detail. The facilitator ensured that the focus group followed the desired structure but also allowed the discussions to flow in a natural open manner where appropriate. The focus group was a great success and provided LMC with some excellent information which is presented throughout the rest of this report.

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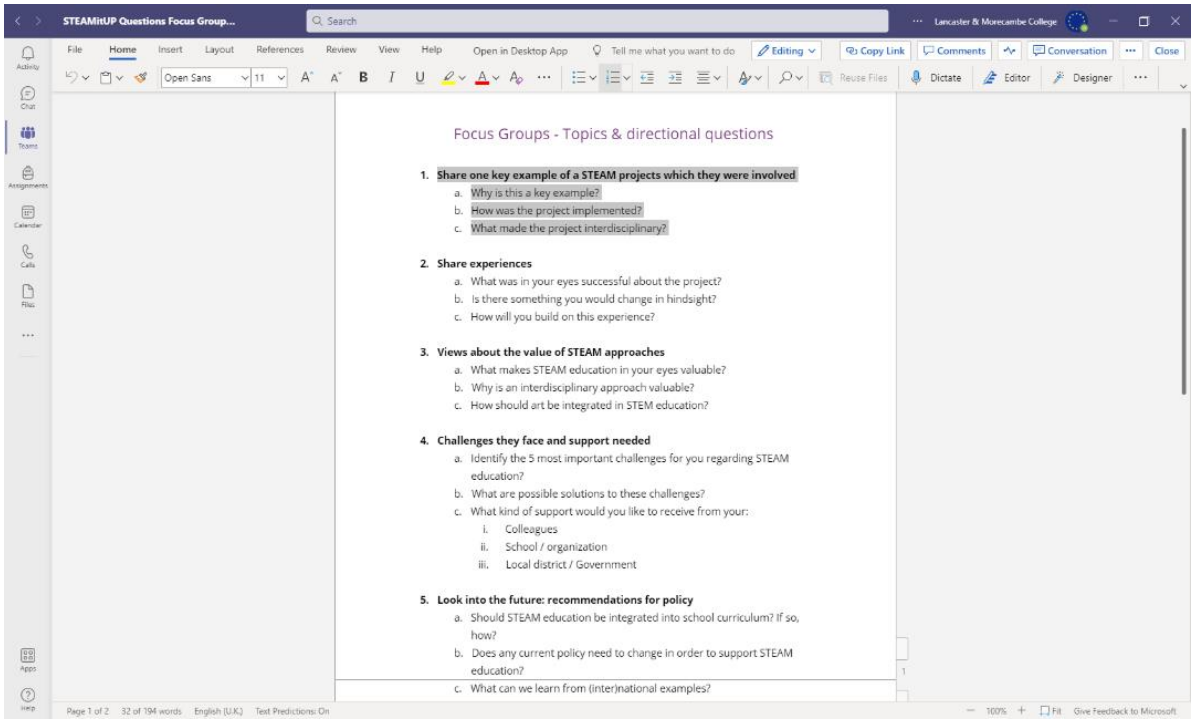

Focus Groups - Topics & directional questions

1. **Share one key example of a STEAM projects which they were involved**
   a. Why is this a key example?
   b. How was the project implemented?
   c. What made the project interdisciplinary?

2. **Share experiences**
   a. What was in your eyes successful about the project?
   b. Is there something you would change in hindsight?
   c. How will you build on this experience?

3. **Views about the value of STEAM approaches**
   a. What makes STEAM education in your eyes valuable?
   b. Why is an interdisciplinary approach valuable?
   c. How should art be integrated in STEM education?

4. **Challenges they face and support needed**
   a. Identify the 5 most important challenges for you regarding STEAM education?
   b. What are possible solutions to these challenges?
   c. What kind of support would you like to receive from your:
      i. Colleagues
      ii. School / organization
      iii. Local district / Government

5. **Look into the future: recommendations for policy**
   a. Should STEAM education be integrated into school curriculum? If so, how?
   b. Does any current policy need to change in order to support STEAM education?
   c. What can we learn from (inter)national examples?

Focus Group Discussion Points and Key Findings

The participants involved in the UK focus group included a Principal of a vocational college, a primary school Headteacher, three faculty leaders from STEAM fields and a representative of a local STEAM industry body. LMC felt that this selection of decision makers represented a varied cross-section of the different levels and fields of education and matched the key target groups of the STEAMitUP project.

The following section is an overview of the focus group discussion points including some key testimonial comments made by the participants.

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Discussion Point One: Previous experience of working on STEAM focussed projects / initiatives

All participants had some previous experience of either being directly or indirectly involved in STEAM focussed educational initiatives. Each participant provided a brief best practice example including details on what the aims were and how it was implemented.

All of the examples provided were interdisciplinary but two of the initiatives were solely STEM focussed as they had been part of a UK Department of Education drive to increase participation in those fields prior to the push to include Arts as an additional priority.

Each participant had found the experience positive and their initiatives to be successful to a point. However, one participant stated that,

> *"often these types of initiatives seem to be slightly reactive in their approach and never get to the root cause of the underlying issues at hand. We will be tasked with implementing a project or initiative to address a complex and systematic issue that requires wholesale reform of the educational system, it is simply impossible to achieve the aims to the level expected with either the scale, scope or budgets available"*

The other participant agreed with this point and this led to a discussion around the difference between school led initiatives and those prompted or mandated from local or central government. All participants thought that the best initiatives were school led based on the specific needs of their student / staff cohort and the local economic needs or

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conditions as this ensured it was relevant and relatable at all levels. One of the participants framed it as,

> *"in order for any STEAM project or initiative to be successful and to have the desired impacts, the whole school community needs to be involved from the planning to the implementation phases. If implemented via a 'top-down' as opposed to a 'bottom-up' strategy it can often seem as though you are only doing things because you have to rather than in order to make a lasting and meaningful change. This then makes it increasingly difficult to get the required 'buy-in' from all the necessary parties"*

Again, the participants agreed with this statement and added that a well-managed project / initiative can be used as a foundation or launching platform for broader change to achieve a specific objective or to improve a school's approach to the STEAM fields in general.

Discussion Point Two: The value of the STEAM fields in education

All participants agreed that the STEAM fields are vital in today's education and economic landscape. They all believe that an increasing number of sectors and employment opportunities for students leaving education are and will continue to be linked to the STEAM fields. The issues of innovation, creative thinking and the ability to adapt to a fluid employment landscape were all raised by the participants. When asked directly *'in your opinion, what makes STEAM education valuable'*, the following responses were provided:

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"the STEAM fields are at the core of education, innovation and development. They form the basis of some many potential opportunities and if studied to the necessary level can be the foundation of a long and rewarding career";

"the STEAM subjects are vital to a young person's education, they provide a broad understanding of the world around us and help provide a framework of knowledge that underpins many of our life experiences";

"each of the STEAM subjects offer a diverse range of topics that cover the majority of our understanding of the physical world and even human culture. At a fundamental level they encourage the development of the key skills of creative thinking and problem solving";

"the STEAM fields cover such a broad range of different topics and potential areas of study that it can often be counter-productive to group them together in such a way as we do. Each of the fields are vital in their own right, but an interdisciplinary approach can really support a learner's understanding as each discipline overlaps and supplements the others";

"the STEAM fields form a key part of any educational journey and offer the student all the necessary tools to develop an understanding of the world. A strong STEAM offer is vital to educational institutions and provides students with opportunities to fulfil their potential and go onto a successful career";

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"having a well-educated STEAM focused workforce is vital to our economic growth, opportunities for innovation and potential for development. Many of the growth industries are linked to the STEAM fields in some way and this is likely to continue to be the trend going forward with the increasing influence of advanced technologies and a move away from more 'traditional' roles".

This was an interesting discussion point that was followed up by a question regarding the importance of utilising an interdisciplinary approach within the STEAM fields. All participants agreed that it was important to include interdisciplinary approaches across the fields but that it can often be difficult to achieve due to the restrictions of strict national curricular and the specific syllabi included within each. All of the participants said that they encourage their teaching staff to use interdisciplinary approaches wherever appropriate to provide students with an understanding of how all the STEAM fields are interconnected and interact at a fundamental level.

The final question within this discussion area was, *'how do you manage to effectively integrate the Arts into STEM education?'*. This was quite a detailed discussion and the below is an outline of some of the responses:

"this has been a challenge as for a long time we were told to focus on the STEM fields as a priority, especially in relation to female participation. We had established a key strategic approach to this and were then asked to refocus our efforts on the Arts as they were seen to have been overlooked, probably as a result of our increased focus on the

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STEM subjects as required. So, STEM became STEAM and we had to adapt our strategy to bring our Arts provision in line with the other fields";

"the inclusion of the Arts along with STEM is a more recent development in the UK and has required a systematic realignment of the Arts subjects to give them an 'equal' importance in school education. Our Arts faculty had felt that they had been neglected as a result of the STEM focus for several years, which had led to a decrease in funding and budgets for the Art subjects on a per pupil basis. The remedy this issue, we liaised with our Arts faculty to develop an action plan for incorporating the subjects within the structure of our STEM provision and implemented each step over the course of the following two academic years. This has had mixed successes and we are still in the process of giving the Arts equal focus as the STEM fields";

"it can be difficult to incorporate the Arts into your STEM provision but it is vital in order to provide a broad and quality educational offer to your students. The Arts and creative industries provide a huge contribution to the UK economy and it is one of our key strengths on the global stage. Your Arts faculty has to be empowered to push boundaries and establish their value alongside the STEM subjects. There is also an issue with the Arts curriculum as most students are required to choose only one of the Arts subjects to study beyond a certain level which can have a restrictive impact depending on the number of students progressing to each discipline".

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Discussion Point Three: The challenges faced and support required for successful STEAM initiatives

This discussion was quite detailed and vigorous with all participants contributing many valuable points. The participants were first asked to provide what they saw as the five most important challenges to their STEAM educational provision. The five issues that were raised the most were:

1. **Curricular restrictions** – the limitations of the different STEAM curricula and how teachers are focussed on helping students meet certain educational targets and to successfully progress through their exams. Having to adhere to very strict curricula can limit opportunities for innovation and dynamic pedagogic approaches;
2. **Difficulties delivering interdisciplinary lessons** – linked to the above point but this is more related to the frontline delivery of lessons. A lack of resources and equipment can often limit your opportunities to run interdisciplinary lessons. Teachers generally specialise in specific fields and therefore do not feel confident delivering interdisciplinary lessons;
3. **Funding limitations in relation to equipment and staffing** – a lack of funding for the most up to date industry standard equipment, learning spaces and teaching time can limit a school's ability to implement STEAM initiatives. Teacher time is also a serious issue as they have limited opportunities to plan, implement and manage projects alongside their teaching commitments;

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4. **Gender divide in participation across the fields** – this varies across the different STEAM areas, most participants state that there are more male students taking Technology or Engineering, more females taking the Arts, and a more equal distribution in Mathematics when studying at a higher level. In the Sciences it seems that there are differences between the disciplines with more male students taking Physics, more females taking Biology and a more even distribution in Chemistry when studied at a higher level;
5. **Lack of time and opportunities for CPD** – the ability for teachers to complete the necessary professional development to keep up with the latest trends in each field (especially engineering, IT and technology) is a serious issue. It is very difficult to offer teachers the sufficient time away from the classroom to undertake training and CPD and when it is possible they are often limited to more generic training that is mandated by the educational regulators. It is almost impossible to offer CPD opportunities that would support the delivery of innovative STEAM lessons across our staff cohorts.

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The participants were then asked for some ideas for possible solutions to the challenges identified above, their responses included:

1. Increases in per pupil funding from local and/or central government;
2. Increased dedicated time for staff CPD each month with increases in staffing allowances to cover classroom time;
3. Regular STEAM dedicated activities including interdisciplinary workshops, extra-curricular activities and industry linked events;
4. Having more flexible curricula to empower teachers and provide some freedom in relation to the delivery of the STEAM fields;
5. Alter the National Curriculum to include more STEAM lessons and have an increased focus at primary level to build a foundational understanding at a young age which then will hopefully build an increased confidence in students as they progress through the different levels of education.

Discussion Point Four: Female Participation in the STEAM fields

This discussion point raised a lot of interesting and important issues that covered aspects of gender stereotypes, societal influences and cultural norms. The group revisited some of the discussion points from earlier in the focus group regarding gender participation differences in some of the STEAM fields.

All participants agreed that there were some fundamental issues in how some subjects are viewed which influences many student's decisions in whether to continue to study them

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beyond a certain mandated level. However, all participants stated that they had seen some positive changes in relation to increased female participation, especially in the STEM fields, over the past few years. Here are some of the points raised by participants in relation to this issue:

> *"for many years there has been some kind of invisible mental barrier for some female students when it comes to progressing onto studying some of the STEAM subjects at a higher level. I believe it comes from a stereotype about the more 'technical' subjects with female students often being put off such subjects from a young age which then leads them to have less confidence studying them at a higher level"*;
>
> *"female participation in the STEM fields has increased markedly in recent years but there is still an issue with how many female students view Mathematics, Engineering, Technology and some of the Scientific disciplines. These fields are still predominantly male dominated in further education, higher education and in industry. Hopefully, if the current trends continue this will be less of an issue in coming years"*;
>
> *"certain subjects and industries are still seen as either more feminine or masculine focussed by society and even within academia to a point. These societal or cultural norms permeate into how students see these subjects and it influences the likelihood of them wanting to follow a career in those fields. Many female students are either directly or indirectly dissuaded from following certain academic or career paths. This seems to be changing for the better but it is still an issue we have to deal with every day in education"*.

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Discussion Point Five: Policy recommendations to improve STEAM education

The final discussion involved the participants coming up with some potential solutions to address the issues that had arisen during the previous discussions. The solutions were recorded in the form of five key policy recommendations that are outlined in the following section of this report. Participants discussed how STEAM education should be further integrated into the school curriculum, how educational policy could be changed to support the STEAM fields and what can be learnt from other national / international examples of best practice.

Policy Recommendations

As a result of the focus group discussion, LMC have put forward the following policy recommendations towards the overall collective project position:

1. STEAM extra-curricular activities – encourage and support schools to implement regular STEAM clubs, workshops or any extra-curricular activities that promote STEAM education at all levels. Initiative such as Robotics, Coding, Graphic Design or Music clubs should be part of every school community and funding should be provided to support such activities;

2. STEAM curricula that responds to a changing landscape – education can often struggle to key up to date with the ever-changing industrial and economic landscape. As the national curriculum is so large and cumbersome it can be really challenging to adapt to trends or new technological advances. Having a more flexible STEAM curricula that can be

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tailored to fit the individual needs of a community or local economic / industrial landscape could empower schools and teachers to adjust their STEAM provision as and when required in order to meet the needs of both students and the STEAM industries.

3. Encourage an interdisciplinary approach – at every opportunity teachers and school decision makers should look to implement interdisciplinary workshops alongside their more traditional planned lessons. Providing as many opportunities for cross-curricular STEAM workshops would heighten student's understanding of the interconnectedness of the disciplines and how they interact together outside of educational settings;

4. Primary and Secondary Schools to be 'partnered' with Universities – creating links between educational institutions is a vital process to ensure a more 'joined-up' approach. Too often schools, colleges and universities are either in competition for students, funding or attention from the governing bodies. This situation is counter-productive and extremely unhelpful for the overall educational picture of the region or country as a whole. Creating positive and productive relationships between local schools and universities can really support the STEAM fields and promote further study. Bringing together learners of different ages may provide excellent role models or examples of successes for the younger students to follow. These relationships can also encourage the sharing of equipment and facilities that can help overcome funding issues.

5. Link education with industry at every opportunity – grounding a student's education in the 'real world' is vital to developing a deeper understanding of the often-abstract topics they study at school. Holding regular STEAM industry events or career fairs is one way of achieving this. However, nurturing strong links between an educational institution and local

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representatives of the STEAM industries creates a valuable, rewarding and reciprocal relationship that can be vital to encouraging students to follow STEAM careers. Inviting STEAM industries on to your campus to run workshops and showcase what they do or facilitating field trips to STEAM industry facilities for students to see the disciplines in action are both excellent strategies but will require a certain time commitment from the parties involved.

All of these policy recommendations have their strengths and some inherent issues that would need to be addressed for them to be implemented in any educational setting. They were formulated throughout the discussions and streamlined into more coherent actions during the final stages of the focus group.

Some of the recommendations can be achieved by a school independently while others require a wholesale reassessment of how the STEAM disciplines are managed from a Department of Education level. The key is to continue the discussion and for all interested parties to be involved at every level in order to overcome the challenges faced and ensure our educational system develops well-rounded, inquisitive and confident young people.

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Conclusion

The UK STEAMitUP Policy Recommendation Focus Group was a fantastic opportunity to bring together some key decision makers within the fields of STEAM education. The focus group worked as LMC had hoped and all the participants contributed to the discussions and were open and candid in their contributions. We were happy with the levels of discussion that took place and the key policy recommendations that came as a result.

If we were to facilitate another focus group then we would have preferred to have undertaken it in person rather than virtually, but this was necessary due to COVID-19 restrictions. We would have also provided more time for free-form discussion as there were times when the facilitator had to close off a discussion in order to move onto the next point due to participant time restraints.

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National Report (Netherlands) – 9th November 2021

Focus Groups for Policy Recommendations

Focus Group Summary

On November 9, 2021, the RUG representatives for the project held an online focus group. This focus group took slightly longer than one hour and was held using Google Meets, due to the difficulties in gathering everyone together in person. There were no technical difficulties experienced and the meeting was recorded with the permission of the participants. There was a total of 7 participants excluding the moderator and assistant moderator from RUG. These seven participants possessed a variety of STEAM-related knowledge and expertise, from Directors, Lecturers to PhD students and Art teachers. This allowed for the focus group to cover a wide array of relevant topics and policy recommendations from the local to the regional levels, having given both Dutch and international perspectives.

Examples and discussion of STEAM projects

The focus group started with sharing of past experiences related to STEAM projects and any notable projects that were good learning experience in the past. Multiple participants shared their experience of specific STEAM projects and how these projects were interdisciplinary, as well as the benefits associated with them and how they turned out in the end. It was of note how technically advanced projects were for primary school children, involving robotics kits and some programming.

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Furthermore, all the example projects mentioned already incorporated Art into STEM in unexpected ways (design their own plant and use a bee bot to design a maze), and all of these were projects for primary school students. The learning objectives and outcomes were also shared by the focus group participants to emphasize what worked well and what didn't.

Implementation of STEAM projects: challenges and difficulties

Following this, the discussion shifted to the implementation of STEAM projects, with different examples given. This portion of the discussion focused mostly on the difficulties or challenges that come together with implementing STEAM projects, such as the lack of resources or the lack of knowledge and expertise to best utilize resources. This was in reference to teachers which have great facilities but no knowledge of how to best utilize them – a comparison was made to giving a toddler a Ferrari. A key point mentioned by multiple participants was that having support from the management or school board was a huge help in successfully implementing STEAM projects.

Another point which was brought up several times was that familiarity is highly important, referring specifically to teachers needing to be familiar with the subject they are teaching (or tools they are using). This can range from being confident in teaching a new concept to students or familiarizing yourself with a new robotics kit before using it for an upcoming project. There are also cases where teachers themselves feel apprehensive about teaching a topic they do not fully grasp.

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This was one of the longest discussion sessions of the focus groups, and almost every participant had something to add in this section. One of the recurring points was the availability of resources could change the outcome and success of a project. Resources could mean textbooks, computers, robotics kits or an allowance for travel. Furthermore, the time in which resources are available to students was also mentioned as being very important. Just like how there are after-school activities for sports or drama subjects, so there should be activities available for students interested in STEAM. During these after-school times students can play around with new equipment and find how to best make use of it. If students who are actively interested in STEAM do not have the opportunities to pursue this curiosity after-class that will greatly limit potential growth of STEAM in the future.

One of the participants added that what STEAM needed was a stage. A place where STEAM can be publicly promoted whether in school or outside of school. By providing a public stage for STEAM and allowing students to present their work, their motivation to improve and have pride in their work will grow. In the end, inspiring the wider community can help drive STEAM projects forward.

In Hindsight: How would you improve on past STEAM projects?

The focus group conversation was not very structured, and due to this a lot of points that were meant to be discussed later ended up being mentioned earlier. For instance, ways to improve on STEAM projects were touched upon in the previous, larger section.

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Some of these include having specific teacher training, to help teachers familiarize themselves with new technologies / tools and gain more confidence in their own knowledge. One of the participants mentioned for a specific project he would've liked a period before the start of the project for teachers to play around with the new equipment so they could make the most out of teaching the students when the time came. This would also incentivize more teachers to pick up STEAM.

A very important point was the need to document STEAM projects. This was echoed by multiple other participants, and they all stated this would have been highly beneficial for all their projects. Currently, there is no database or location of files and documents for respective STEAM projects. There is a large amount of missing information which could help understand why certain projects failed and what could be done to avoid such failure in the future.

Looking at STEAM from a school's perspective, there are some schools that are very keen to implement STEAM education and projects and have the funding and expertise necessary to do so. Other schools may want to implement STEAM but are lacking in funds or time to do so, while another category of schools simply do not want to implement STEAM, whether because they do not see the merit in it or due to being scared of the new, unknown territory. By having a database of documents of past projects, there are more opportunities for many more schools to adopt STEAM practices and implement projects. This was a very eagerly discussed point, reinforcing the importance of having access to past project documents and files.

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Support for STEAM: local / state support to help STEAM projects

This section focuses on what sort of changes could be made at a government level (local government up to ministry of education) to help facilitate and support STEAM projects. An aforementioned example would be having extracurricular STEAM workshops where students can go after school time or in their free time. This would foster more interest in STEAM and eventually lead to more children getting interested in STEAM at a higher level of education. This could also be further aided by collaboration between institutions, such as applied universities and local museums.

A state allocated budget meant for travel and potentially food expenses would help certain teachers a huge amount. One of the participants staunchly stated that there are numerous resources nearby their school, by train. However, due to financial constraints be it from students or teachers, these nearby resources do not get utilized to their full potential. This is particularly the case for foreign teachers which did not grow up in this environment, compared to a local teacher which may overlook obvious destination points due to having visited many times or students being bored of that place having already seen it in the past.

Art in STEAM and integrating STEAM into the curriculum

This section covers multiple smaller discussion segments from the focus group, where there were fewer responses or a consensus. The main point which was brought up was that there should be more communication between different institutions which are involved in STEAM.

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If one group from Groningen comes up with some great learning objectives and how to implement them, it would be a waste if this information was not conveyed over to a group in Amsterdam. This would be very helpful from a policy point of view and sharing expertise between groups and projects will be beneficial for the community in the long-term. There should be more regular communication between members of different STEAM groups and projects – this was the main takeaway.

When asked about Art and STEM the participants made it clear their views did not separate the Arts from STEM, and many of them believed STEAM education was impossible without the Arts. One of the participants mentioned a project that was done with the ministry of infrastructure, where students had to design an eco-duct (a bridge over a highway which animals use to travel across unimpeded). Students had to approach this project from many perspectives (science, design, history, engineering etc.) Although there were some older students who did not much care for the project, the overall enthusiasm for the project was very high, as this was the first time they could apply in practice the subjects they had studied in school. According to one of the participants, Art is needed to give context to STEAM.

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National Report (Spain) – 18th November 2021

Focus Groups for Policy Recommendations

Focus Group Summary

This Focus Group was carried out with experts in the education system, nursery and primary school teachers, a university teacher and an educational psychologist. First, they were put in context and given a presentation of the project, its results and objectives. Afterwards, the discussion started around a series of questions previously provided by the University of Groningen. While it is true that we had these guiding questions, the discussion revolved around, above all, one main idea: teacher education. This idea comes up in every line of discussion, as it is essential that, in order to be able to carry out innovative projects, teacher training has to be innovative, as well as, that there is an agreement between governmental educational organizations, schools, but also companies and their innovative reality.

Focus Group

On 18 November 2021, the Focus Group for the Policy Recommendations Report of the STEAMitUP project took place in Spain. The focus group lasted one hour between four and five o'clock in the afternoon. It was conducted online through the Zoom tool. Due to the current situation of COVID-19, we were not able to bring the participants together and it was carried out through a virtual call. The tool worked perfectly and there was no problem for each participant to share ideas and experiences.

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We were able to count on the participation of seven people related to the world of education. Five of these seven people were primary and secondary school teachers, we also had a university professor who teaches future teachers and an educational psychologist. As the project is focused on this target group, the comments obtained by the participants and their points of view were of great value to know the real implication that the STEAMitUP project can have in schools in Spain.

We started with a brief presentation of the project to contextualize the participants in the focus group topic. The Intellectual Outputs of the Project were presented, the Toolkit and the e-Learning Platform in more depth, as well as the website and the partners and working entities of the Project. Finally, in order to guide participants to their commitment in the focus group, the Policy Recommendation paper was presented.

The first topic that came up was their direct knowledge of the term STEAM. We could see, after a short summary of the project, that they were more familiar with the term STEM. This is normal since, as the University teacher pointed out, the term STEAM started to be discussed from 2018, related to the topic of competence development.

Afterwards, they had the opportunity to discuss some STEAM-related classroom experiences. Although they had not been involved in any STEAM projects as such, some of the teachers were able to comment that they had worked in schools where the subject methodology had been eliminated and they had started to work by competences, especially in the infant and primary stages. It becomes more complicated at secondary level, as the years following primary education are more focused in preparing students to pass exams

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that will let them study different university careers, depending on their score. These preparation to exams leads to a way of evaluating students more focused on a numerical score, rather than on the actual achievement of knowledge. In methodologies like STEAM, which are focused on interdisciplinary approaches with the transversality of the subjects as the core part of the methodology, the subject-based assessment becomes diffuse. However, participants express the importance of changing the actual way of teaching in secondary levels and they expressed the possibility of implementing also this type of projects in these school years.

They found it interesting to implement projects such as STEAMitUP within the academic curriculum, so as not to force the teaching of technology, coding or robotics. At this point, however, another of the key issues in our Focus Group came up: teacher training.

"A key factor is teacher training."

All the participants agreed that, no matter how many projects on the promotion of STEAM there are, if there is no training focused on this methodology in teacher training, i.e. in university teacher training degrees and master's degrees, it is very difficult for it to be implemented in the classroom. They, therefore, proposed a political change with the support of external organizations (companies and the labor market). In other words, a change of system that adapts to the methodology we propose.

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They believe that the didactics taught in teacher training degrees is outdated. The future lies in projects and continuous assessment, but in the four years of university teacher training they are not trained for a future of teaching practice. They stressed that it makes no sense to change the methodology in the primary and secondary stages, if students and teachers are then faced with university entrance exams based on subjects and not on competences.

As we had a university teacher within the participants of the debate, he could express his feeling about this issue. He agreed with most of the comments, as he also studied the same career and could see the gaps of the teacher training curriculum from the inside. However, now as university teacher, he states that he is trying to overcome all the bad things he could identify when being a student, so their students don't feel unprepared when facing their future teaching practice in schools.

This sense of hope with the new university professors was also reflected when talking about school teachers. Many of the teachers who are now in the schools are older and not very keen to innovate. However, little by little a large number of future educators are emerging who are eager to implement new things in schools, eager to improve the education received in the past and eager to make real changes that can improve the status of schools and teachers as professionals.

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Final Recommendations

To conclude the discussion, they were asked to give, in a few words, recommendations they would make to those responsible for legislating for the education system. This is the result we got:

- In-service teacher training
- Giving motivation the importance it deserves
- Develop a critical approach: educate for the world we live in
- Collaborate: take into account who is in the classroom and how they are. In other words, to take into account education professionals.

"In order for us, as primary and early childhood teachers, to be able to implement this type of project, we need university education to be of high quality, up to the task and focused on the future we are going to face."

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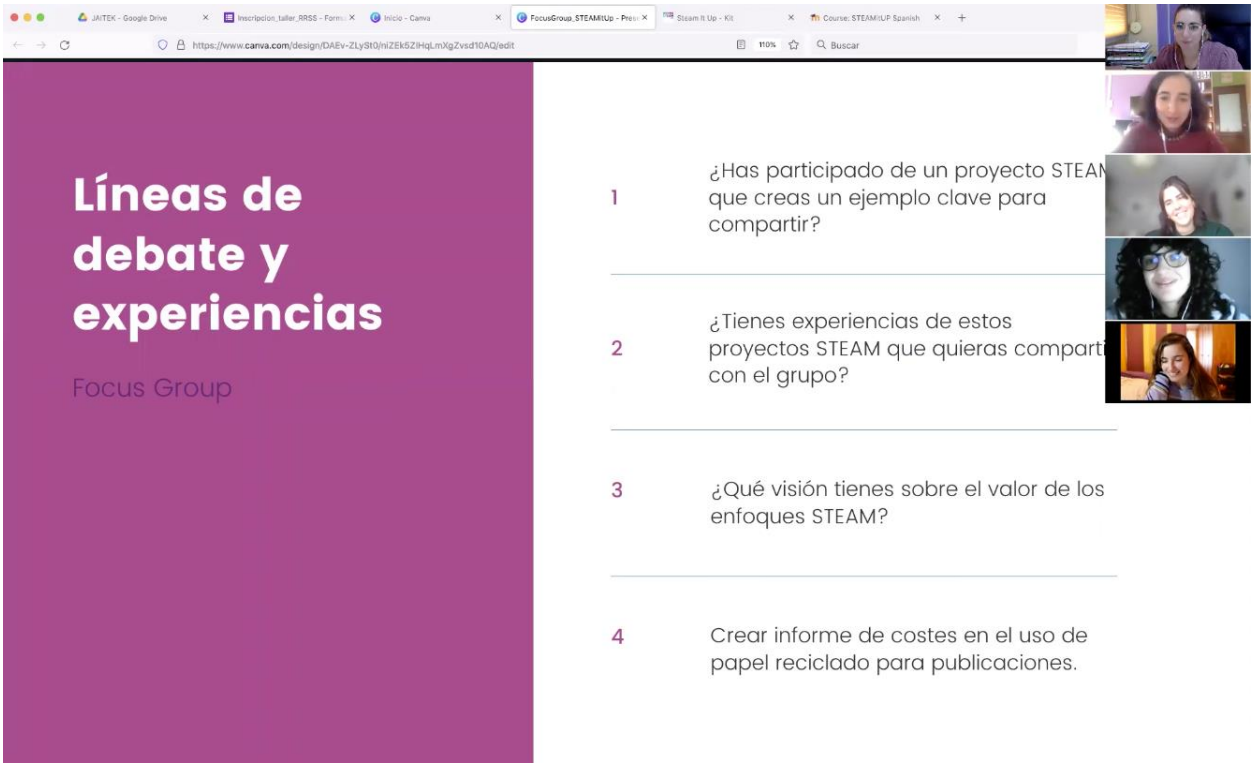

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National Report (Ireland) – 11th November 2021

Focus Groups for Policy Recommendations

Focus Group Summary

To support the development of the STEAMitUP Policy Paper, FIP hosted an online focus group with educators on Thursday, 11th November. The focus group had a duration of 2 hours and was hosted by FIP through Microsoft Teams. The aim of this session was to elicit feedback from stakeholders on the STEAMitUP model and approach to delivering a cross-curricular approach to STEAM education. Our intention was to engage teachers and school managers who had been directly engaged in the piloting. However, at the time, Ireland was experiencing increasing cases of COVID-19 among teaching staff and students in secondary and primary schools. Therefore, we had to engage some stakeholders who were new to the STEAM project to ensure that we could reach a quorum for the focus group. On the day, we engaged 6 educators, who all worked in either secondary or vocational education schools, and who each were engaged in teaching or supporting the teaching of STEAM subjects. To begin this session, FIP presented an overview of the STEAMitUP project, and shared some feedback which we had received through the piloting and impact assessment of the STEAMitUP materials. Based on these presentations, we started a conversation with the participants to gain their insight and perspective about the STEAMitUP approach to STEAM education.

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Examples and discussion of STEAM projects

Following on from our presentation of the STEAMitUP project, FIP engaged focus group participants in sharing examples of STEAM projects that they had previously been involved in. As the participants were teachers or school leaders, they did not have much experience of collaborating in transnational projects like STEAMitUP. They were very interested to learn more about the opportunities open to them to engage in these projects. When sharing examples, these tended to relate to available curriculum materials for teaching STEAM in Ireland. Participants mentioned resources that are available through websites like SchoolNet. They also mentioned the BT Young Scientist National Campaign, which supports secondary school students to develop a science project, with some projects selected to exhibit at the Young Scientist Exhibition in Dublin once a year.

From the participants in the focus group, two schools had experience of entering this competition, but neither had won the competition. Other than this, they mentioned that they were aware of Lego kits for teaching robotics, but that using these in primary and secondary teaching was not commonplace in Ireland due to various reasons, including a lack of IT infrastructure, a lack of CPD for teachers and in some locations, limited internet access to support these activities. Teachers also mentioned that they do dedicate a lot of time to exploring the lived environment in their teaching and raising awareness of environmental science and biodiversity preservation among their students, especially those in primary school. It was mentioned that this is heavily influenced by the climate change curriculum that is being introduced at primary level in Ireland.

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Implementation of STEAM projects: challenges and difficulties

This discussion led quite well into a dialogue which identified the challenges and difficulties experienced when implementing such STEAM projects in the classroom. Teachers expressed that the motivation of the students was not as issue as many students, especially girls, are interested in STEAM careers these days. This was seen as a positive, as there has been significant effort over the past decade to promote STEAM careers with female students, especially considering the large technology and pharmaceutical industries in Ireland. However, the difficulty lies in the lack of resources – internet access, access to iPads and computers, access to robotics kits and other teaching materials – and also the lack of suitable teaching activities that follow a cross-curricular approach as is advocated by the STEAMitUP project. Teachers were very interested in this approach, as they commented that it was very innovative and creative, and not something that is practiced at any level of education in Ireland.

Where they saw a challenge with this cross-curricular approach is in the need for teachers from Art and Science, for example, to collaborate to teach a class. Teachers shared that this is 'unrealistic' as many schools are under-resources and under-staffed, especially today with COVID-19 causing more teachers to miss school time due to sick leave and being close contacts to other confirmed cases – so to ask teachers from different disciplines to come together and teach their subjects in a collaborative way would be a huge challenge, especially for rural schools in Ireland with small staff numbers.

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Focus group respondents also noted that where teachers could deliver such activities, often they lack the practice and skills to be able to deliver sessions using modern technology like robotics kits. It was mentioned that there is a need to undertake a national continuous professional development program for teachers in how to use robotics kits, and then schools would actually need to receive a suite of robotics kits to be able to teach in this way to students. However, this again was seen as 'unrealistic' for schools. In Ireland, many schools receive an annual grant of between €800 and €2,000, depending on student population, from the Department of Education, and this is to cover all technology expenditure. For example, one school represented in this group mentioned that they had just used their grant to have internet installed in the school for the first time. This shows the level that some schools are at in terms of applying digital teaching methodologies in primary schools, and also shows how much investment would be needed to roll out a robotics teaching program in primary schools. There was a lot of interest in this topic among focus group participants, but it was also recognised that there are many challenges and obstacles to overcome before this is feasible for primary schools in Ireland.

Another challenge with implementing this cross-curricular approach to STEAM is that the school curriculum in Ireland is 'full'. This means that teachers have a heavy curriculum to deliver and limited time to take on additional or extra-curricular project work. Participants also highlighted that since the school closures during COVID-19, many of the schools were struggling to catch up on the curriculum work that was missed during this time, when

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students were being home-schooled. As such, while they were enthusiastic and interested in the STEAMitUP approach, it was generally agreed that it is not the right time now to deliver such a program in schools in our region.

In Hindsight: How would you improve on past STEAM projects?

When asked about how they would improve past STEAM project, participants noted that they had limited experience of delivering such technology-enhanced STEAM projects; but that what has held them back is a lack of available training for teachers and a lack of IT equipment to deliver these projects. Therefore, after discussing specific improvements – faster internet, more iPads for students, access to robotics kits for teaching – they summarised that the best way to improve how STEAM projects are delivered in schools is through investment in equipment and investment in teacher-training to be able to confidently deliver such projects in schools. It was again reiterated that the motivation to learn STEAM and engage in creative projects like the ones promoted in the STEAMitUP project is there for students, but the lack of resources and the lack of training for teachers, holds this process back.

Support for STEAM: local / state support to help STEAM projects

Focus group participants were then asked to list the ways that local or state support could help the improvement of STEAM projects in schools. Here, again, participants mentioned the need to increase the support for teachers to develop their skills in delivering STEAM projects. For example, it was thought that a series of nationally accredited short courses on using

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robotics, Lego kits, Scratch, virtual reality, Google Workspace, augmented reality, HTML, App Inventor, gamification, artificial intelligence, etc. would help teachers to customise their teaching practice so that they could use the best or most suitable approach in their STEAM teaching. It was noted that these courses would have to be nationally accredited to have value for teachers, as they would be counted as continuous professional development hours for teachers.

It was also shared that a national STEAM fund for schools could be opened so that schools in need of additional IT infrastructure could apply for funding to update the resources that they have in the school. While this would be a competitive call, participants mentioned that there are some schools that are 'streets ahead' of schools in rural Ireland, and so a fund that would support rural schools to update their IT would be very beneficial to students and teachers in these schools. It was also mentioned here that there is a need to prepare students to use technology responsibly, and to be taught in a way that is engaging for them. When they go home, the majority of students have a smartphone to tablet, and then when they are in school, they are being taught through books and charts which have been in use for quite some time. In order to prepare students to be able to enter STEAM jobs, it is important that this type of investment is made in how they are educated from a young age.

Lastly, participants mentioned that as part of the National Science Teachers Network, there could be a STEAM support committee that would allow for teachers to explore how STEAM could be taught in cross-curricular approaches; and that having this type of peer support and networking could be very beneficial to teachers who might be new to this approach.

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Art in STEAM and integrating STEAM into the curriculum

Lastly, when asked about how the integrate Art into STEAM education, participants noted that sometimes in their practice, they see Art as the forgotten subject in STEAM. With the lack of resources and the lack of collaboration between Science and Art teachers, for example, the participants shared that there are not many best practices or activities that they can follow to successfully integrate Art into their STEAM teaching. This was from a practitioner perspective; and when the focus group participants engaged in a discussion about this, they were able to come up with some examples of how Art could be integrated into STEAM. This was prompted by the facilitator from FIP who suggested that Engineering could be taught through sculpture, or Mathematics through music, for example. This sparked some conversation between focus group participants, but still the same issues arose during this discussion – the curriculum is full and additional activities like this are not possible during teaching hours, however they would make an interesting after-school program; availability of teachers to teach these cross-curricular sessions is an issue; lack of teacher-training in these approaches; lack of resources to deliver such sessions in schools. There was a sense from the focus group participants that they would love the opportunity to explore these creative means of teaching STEAM, but that the reality for schools is that with a lack of support and resources, these activities would have to wait until the situation improves. However, they did agree that where private providers could deliver these sessions in schools, there would be considerable interest, especially from students.

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Conclusion

In a highly technologized world, a competent citizenship in the fields of Science, Technology, Engineering, Arts, and Mathematics (STEAM) is more needed than ever. STEAM education and tools offer today new ways of learning, open up new possibilities for education, and give opportunities to access the job market. The importance for STEAM education for meeting the demands of today's knowledge-based economy is underlined by European SchoolNet and decades of research carried out by academics and researchers. However, in order for young people to seize the new opportunities and reap the benefits, the education system needs to innovate and respond to these changing realities by equipping students with the necessary knowledge, competences, and skills.

STEAM education has been proven to be a promising methodology which supports the development of the 21st century skills to students. STEAM increases critical thinking, provides a unique way to problem-solving, give all students unique experiences, encourages girls to explore STEM fields, and shows students a different way to value the arts enabling them to be the innovators, educators, leaders and learners of tomorrow.

This document provides useful and concrete input collected through focus groups done in the partner-countries of STEAMitUP. It synthesizes examples of STEAM projects and experiences, the views of key individuals ranging from teachers to researchers to policy makers about STEAM and its value, it provides a set of challenges faced when attempting to

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implement STEAM approaches to teaching, and it offers a set of policy recommendations. In concluding the following becomes prevalent in this synthesis: perhaps now more than ever STEAM approaches are urgently needed in teaching and learning, but for that to happen a systemic approach to design, implementation and impact evaluation is needed that includes not only curriculum design but investing in equipment and professional development for teachers, curriculum developers, and policy makers as well.

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