



STEAM in SDGs

Encouraging Students To Enhance Their
STEAM Skills In Order To Address
Real-World SDG-Related Challenges

2023-1-PL01-KA220-SCH- 000156257

NEEDS ANALYSIS REPORT



Co-funded by
the European Union



Abstract

This study explores approaches for integrating Sustainable Development Goals (SDGs) into Science, Technology, Engineering, Arts, and Mathematics (STEAM) education to motivate students towards active citizenship and cultivate their interest in STEAM fields. Through desk research and a series of focus groups conducted across partner countries, this research investigates the perspectives, needs, and awareness of educators regarding the incorporation of SDGs in STEAM classes. Findings reveal that integrating SDGs in STEAM education serves as a powerful tool to instil values of global responsibility and environmental consciousness among students while enhancing their engagement and interest in STEAM disciplines. Additionally, insights from focus groups shed light on effective teaching strategies, including Learning by Design approach, real-world problem-solving, and interdisciplinary approaches, to effectively convey SDGs concepts in the classroom. Overall, this study offers valuable insights into how educators can leverage SDGs integration in STEAM classes to empower students as proactive and socially conscious citizens while fostering their passion for STEAM disciplines.

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This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Information

Project	STEAMinSDGs - Encouraging students to enhance their STEAM skills in order to address real-world SDG-related challenges
Project N°	2023-1-PL01-KA220-SCH- 000156257
Work Package	WP2/A2 Needs Analysis Report
Date	31/03/2024
Type of Document	Version 1
Language	English
Project website	https://steaminsdgs.eu/

Consortium



Index

Abstract	1
Disclaimer	2
Information	2
Consortium	2
Index	3
DESK RESEARCH	4
Introduction	4
STEM/STEAM Education for Sustainability	4
The Crucial Role of School Education in Achieving the Sustainable Development Goals	5
Conclusions	6
References	7
FOCUS GROUPS REPORTS	10
Introduction	10
Objective	10
Methodology	10
Participants	11
Activity implementation	13
Findings	14
Conclusions	16
Annexes: National Focus Groups by country	18
<i>Poland - Szkoła Podstawowa nr 2 w Proszowicach</i>	18
<i>Estonia - Tamsalu Gymnasium, Estonia</i>	24
<i>Spain - CEIP San Antonio & Formative Footprint</i>	30
<i>Latvia - Latvijas Universitate</i>	36
<i>Greece - E-School Educational Group</i>	43

DESK RESEARCH

Introduction

The global challenges we face today, including climate change, inequality, and biodiversity loss, have prompted the United Nations to establish the '2030 Agenda for Sustainable Development' in 2015, which is centered around 17 Sustainable Development Goals (SDGs). These goals serve as a blueprint for achieving a more equitable, sustainable, and prosperous future, addressing critical areas such as quality education, affordable and clean energy, and climate action.

In the forefront of advancing these goals will be today's students, who will play a crucial role in devising solutions to these pressing issues. Recognizing the pivotal role of science, alongside political efforts, in addressing these challenges underscores the importance of integrating the SDGs into STEAM (Science, Technology, Engineering, Art, and Mathematics) education. This integration not only enriches the curriculum with real-world contexts that align with students' concerns about sustainability and the environment but also fosters the development of 21st-century skills.

Leveraging the SDGs as a teaching tool in STEAM education not only broadens students' understanding of scientific concepts but also instills a sense of global citizenship and responsibility towards fostering sustainable development. This educational approach prepares students to be informed, engaged, and innovative problem-solvers who are capable of contributing to a sustainable future.

STEM/STEAM Education for Sustainability

The evolution of STEM and STEAM education highlights a pivotal shift towards interdisciplinary teaching methods that not only prioritize the development of professionals in Science, Technology, Engineering, Art, and Mathematics but also emphasize the integration of sustainability into the curriculum. This transformation reflects a broader understanding of education as a vehicle for addressing global challenges, with a particular focus on fostering ecological resilience, social justice, and economic viability (Zollman, 2012).

Originally, the STEM acronym was developed by the National Science Foundation (NSF) in the United States during the 1990s, with an initial focus on bolstering national competitiveness through the development of professionals skilled in critical technical areas. However, over time, the concept of STEM education expanded beyond its original scope to embrace a more interdisciplinary pedagogical approach, integrating the various domains covered by the acronym (Chesky et al, 2015).

The emergence of STEAM education in 2007 marked a further evolution of this educational paradigm, introducing the arts and humanities into the mix and advocating for a more holistic curriculum that extends beyond technical knowledge. This inclusion underscores a growing recognition of the importance of creative and critical thinking skills in solving complex global issues (Perignat & Katz-Buonincontro, 2019).

Both STEM and STEAM approaches are characterized by active, meaningful, and authentic learning experiences. They often employ teaching methodologies such as project-based, problem-based, and inquiry-based learning, alongside playful learning strategies including free and guided play, games, and gamification. These methodologies are designed to engage students deeply, building upon their existing knowledge and encouraging active participation in real-world contexts (Rodrigues-Silva & Alsina, 2023). Moreover, the "Learning by Design" method represents a transformative approach in STEAM education, emphasizing an inquiry-based learning paradigm. This pedagogical strategy underscores the critical role of design thinking and problem-solving, engaging students in the active design and creation of solutions addressing real-world challenges (Quigley et al., 2020b). Through a structured framework comprising situated practice, overt instruction, critical framing, and transformed practice, students are propelled into experiences that mimic authentic professional scenarios, enhancing their practical understanding of STEAM concepts (Chung et al., 2020).

The alignment of STEM/STEAM education with sustainability goals is particularly noteworthy. Engineering and technology professionals, educated within these interdisciplinary frameworks, are increasingly seen as crucial to driving progress toward a sustainable future (Varela-Losada et al., 2022). By inverting the traditional rationale from "Education for Sustainability" to "Sustainability for Education", the pressing issues of our time—such as climate change, biodiversity loss, and social inequality—serve as powerful, authentic contexts for learning. These contexts not only enrich the educational experience but also prepare students to contribute meaningfully to the Sustainable Development Goals (SDGs) outlined by the United Nations (Kelley & Knowles, 2016).

The emphasis on STEAM by the United Nations (2018) to achieve the SDGs highlights the necessity of incorporating a wide range of knowledge and skills, beyond technical areas, to effectively address the intertwined social, environmental, and economic challenges facing our world. This perspective underscores the critical role of STEAM education in equipping students with the interdisciplinary understanding and competencies required to navigate and resolve the complex issues of our time.

The Crucial Role of School Education in Achieving the Sustainable Development Goals

Education holds a pivotal role in the global effort to achieve the Sustainable Development Goals (SDGs), serving as the foundation upon which awareness, understanding, and action towards these goals are built (Hopkins & McKeown, 2002). By integrating the principles and

objectives of the SDGs into school curricula, educators can cultivate a generation of informed, compassionate, and proactive citizens, ready to contribute to a sustainable future. School education provides the earliest platform for children to learn about the interconnectedness of global challenges, such as poverty, inequality, climate change, and environmental degradation, and the collective actions required to address them (UNESCO, 2014). Through a comprehensive education that includes the SDGs, students gain a holistic view of how these global issues intersect and affect human and planetary well-being, fostering a deep sense of responsibility and urgency to act.

UNESCO outlines four crucial approaches for implementing SDGs through Education for Sustainable Development (ESD): policy integration, curriculum and textbook inclusion, teacher training, and nuanced evaluation (Rieckmann, 2017). Education systems that incorporate the SDGs, supported by local policies, are better positioned to prepare students for challenges such as climate change and global warming. Including ESD in curricula and textbooks from a young age fosters a culture of problem-solving and innovation (UNESCO, 2014). Moreover, teachers play a vital role in this transformative educational process, necessitating in-depth understanding of ESD and relevant training to effectively impart this knowledge (Buckler & Creech, 2014). Finally, evaluations tailored to the specific content and audience ensure that the educational outcomes align with the objectives of sustainable development (UNESCO, 2014).

Beyond the formal educational framework, the roles of informal and nonformal ESD are equally important in promoting the SDGs. Informal education, derived from everyday activities like watching educational programs or reading about sustainability, and nonformal education, experienced through extracurricular activities such as field trips and workshops, extend learning beyond the classroom (Tamir, 1991). This holistic approach to ESD, encompassing formal, informal, and nonformal education, is crucial for fostering a society that is informed, engaged, and committed to achieving the SDGs. Through such comprehensive educational strategies, school education is not just about academic achievement; it becomes a foundational pillar for sustainable development, empowering future generations to create a more sustainable, equitable, and prosperous world for all (Rieckmann, 2017).

Conclusions

The integration of the Sustainable Development Goals (SDGs) into school education represents a transformative approach to learning that is essential for addressing the complex challenges of our time. By fostering an interdisciplinary understanding through STEM and STEAM education, students are equipped with the knowledge, skills, and values needed to contribute to a sustainable future. This comprehensive educational strategy not only enhances students' academic achievements but also instills a sense of global citizenship and responsibility towards the planet and its inhabitants.

In conclusion, the integration of the SDGs into school curricula is important for cultivating a generation capable of addressing the pressing challenges of our era. The future of our planet and the well-being of its inhabitants depend on our ability to educate young minds on the importance of sustainability. Through dedicated efforts in implementing Education for Sustainable Development across all educational frameworks, we can inspire and mobilize a global movement of knowledgeable and committed individuals, ready to act on the SDGs and transform our world for the better.

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FOCUS GROUPS REPORTS

Introduction

STEAMinSDGs aims to provide teachers with resources to attract, support, and inspire students, especially low-performing students including girls, to raise their awareness and understanding of the SDGs and their connection to STEAM disciplines, thereby fostering their skills and interest in both fields and encouraging them to become active and responsible citizens.

As part of the project, we conducted a series of focus groups with teachers from each participating country in the consortium. The aim was to understand how educators incorporate the Sustainable Development Goals (SDGs) into STEAM classes to inspire students to become engaged and conscientious citizens, while also nurturing their interest in STEAM disciplines.

That section summarizes these findings and feedback from the teachers and draws conclusions and recommendations that will guide the elaboration of the Teacher's Guide.

Objective

The objective of the conducted focus groups has been to gain a comprehensive understanding of teachers' perspectives, needs, and awareness regarding the integration of Sustainable Development Goals (SDGs) into Science, Technology, Engineering, Arts, and Mathematics (STEAM) classes.

Methodology

The "STEAM in SDGs" project embarked on a methodical exploration to ascertain the needs and practices of teachers with regard to integrating Sustainable Development Goals (SDGs) into Science, Technology, Engineering, Arts, and Mathematics (STEAM) education. To effectively compile this data, the project utilized Focus Groups organized in each of the participant country:

- **Purpose:** to gather qualitative insights from front-line educators about the practicalities, challenges, and successes of teaching SDGs within STEAM curricula.

- **Selection of participants:** each partner country conducted a focus group with educators, selected based on their active involvement in teaching STEAM subjects. The choice aimed for diversity in teaching experience, subject expertise, and familiarity with the SDGs.
- **Implementation:** each focus group session lasted approximately 60 minutes and was structured around a guided discussion format. Teachers were first introduced to the project aims before engaging in a dialogue about their experiences and perspectives on integrating SDGs into their teaching practices.
- **Tools for engagement:** the sessions were structured to encourage open communication, with teachers responding to a standardized questionnaire. Responses were then aggregated into a shared document for subsequent analysis.
- **Reporting:** the outcomes of these discussions were meticulously documented in focus group reports, highlighting both the consensus points and the varied perspectives emerging from the different educational contexts represented by the participants.

Participants

The selection and profile of the participants were carefully considered to gain a comprehensive perspective from a cross-section of educational professionals across the partner countries.

Profile Overview

- **Poland:** STEAM Focus Group from Primary School No2 in Proszowice involved seven teachers of Science, Maths and Arts subject whose mean working experience was 18,8 years.
- **Estonia:** Participants came from Tamsalu Gymnasium, with staff teaching various subjects across primary, middle, and high school levels, boasting an average of 19.5 years of teaching experience.
- **Spain:** Twelve teachers proficient in STEAM subjects from CEIP San Antonio participated, including the headmaster, primary school teachers, and specialists in subjects like physical education and religion.
- **Latvia:** Seven female teachers from Riga primary school Rīdze took part, representing disciplines like physics, mathematics, chemistry, biology, and design. Their teaching experience ranged from less than three to more than fifteen years.
- **Greece:** Seven teachers representing primary and secondary education in the Karditsa region were engaged, managed by a partner from the E-SCHOOL Educational Group with expertise in STEAM curriculum development.

The educators' experience varied widely, from those with only a few years in the profession to veterans with several decades of service. This variety ensured that a broad spectrum of perspectives was captured, from fresh eyes to seasoned insights.



Criteria Selection

Priority was given to teachers who demonstrated active engagement and commitment to STEAM disciplines.

Consideration was also given to educators with experience in projects related to the SDGs, aiming to understand the impact of prior exposure on STEAM teaching practices.

The focus groups included teachers from various educational levels to gather a full range of educational experiences and approaches.

Demographics

Participants' teaching experience ranged from 2 to 42 years, reflecting a blend of youthful innovation and seasoned expertise.

The spectrum of subjects included natural sciences, computer science, economics, entrepreneurship, mathematics, arts, and more, providing insights into the integration of SDGs across a broad STEAM curriculum.

Educators from primary, middle, and high school levels contributed, offering a panoramic view of the educational journey through the lens of STEAM and SDGs.

Activity implementation

Preparation

Prior to the focus group discussions, a detailed plan was developed to guide the proceedings. This plan included the objectives, questions to be addressed, and the method for capturing and documenting responses.

Each participating country has been responsible for organizing its focus group.

Conducting the Focus Groups

Each focus group session was approximately 60 minutes long. Settings varied from in-school discussions to virtual meetings, depending on logistical considerations and the preferences of the participating institutions.

Sessions began with an introduction to the "STEAM in SDGs" project, ensuring all participants had a clear understanding of the project's goals and the significance of their contributions.

Each group was moderated by an individual well-versed in the subject matter, capable of guiding the discussion, encouraging participation, and ensuring all voices were heard.

Participants engaged in a structured dialogue based on pre-determined questions that probed their experiences, challenges, and successes in integrating SDGs into STEAM curricula.

Tools and data collection:

- Questionnaires: to capture structured feedback, the same questionnaire has been used by all countries.
- Documentation: the discussions and responses were documented in real-time.

Post-Session activities

Responses from the questionnaires and discussions were systematically analyzed to extract themes, patterns, and notable comments.

A focus group report was compiled for each country, detailing the findings, and providing a narrative that encapsulated the collective experience of the participants.



Outcomes

The focus group activities provided a rich dataset from which to understand the current state of SDG integration in STEAM education across the involved European countries.

The process revealed a range of practices, highlighted areas where resources or training were lacking, and underscored successful strategies that could be replicated or adapted.

The findings from each country's focus group have been synthesized in the present document and will inform the subsequent phases of the "STEAM in SDGs" project, guiding the development of resources and for teachers.

Findings

The focus group activities conducted across Poland, Estonia, Spain, Latvia, and Greece provided a wealth of qualitative data.

The present report synthesizes the key findings derived from the shared experiences and perspectives of the participating teachers.

Demographic Information: teachers from a wide range of STEAM disciplines participated, with varying degrees of teaching experience—from novices to veterans. The majority had a background in teaching subjects that traditionally fall under the STEAM umbrella, such as natural sciences, mathematics, computer science, and arts education.

Awareness and understanding of SDGs: awareness levels of the SDGs varied significantly among participants. While some were well-informed and actively integrating these goals into their curricula, others had little to no prior exposure. The average comfort level with integrating SDGs into the STEAM curriculum was notably moderate, suggesting a need for enhanced familiarization and professional development in this area.

Integration into curriculum: there was a common acknowledgment that SDGs were not being consciously integrated into the STEAM curriculum, often due to a lack of resources or clear methodology on how to do so effectively. Some educators indicated incidental integration,

where elements of SDGs were addressed through related topics like recycling or environmental conservation.

Challenges in teaching SDGs within STEAM disciplines: teachers across countries identified challenges in engaging students with SDGs in the context of STEAM. Key issues included:

- Difficulty in relating SDGs to certain STEAM subjects, particularly in arts and mathematics.
- A lack of concrete examples and materials to facilitate the integration of SDGs into the curriculum.
- Difficulty in fostering a connection between SDGs and the students' immediate environments and lives.

Professional development needs: there was a strong call for professional development opportunities to help educators integrate SDGs into their teaching. Teachers expressed a desire for workshops, resource materials, and technology support, especially in computer modeling and augmented reality (AR), to make the teaching of SDGs more effective and engaging.

Student impact: the reports indicated that when students are engaged in learning that aligns with SDGs, they tend to develop a better understanding and connection with real-world issues. Teachers observed an increase in student motivation and interest when they were able to participate in projects or activities that had tangible outcomes or community impact.

Learning by design: the "learning by design" approach was noted as being beneficial in facilitating the teaching of SDGs within STEAM education. This approach encouraged students to think critically and work on hands-on projects that addressed real-life challenges, aligning well with the goals of both STEAM and SDG frameworks.

Suggestions and feedback: educators suggested that the STEAMinSDGs project could provide more ready-made lesson plans, technological tools for classroom implementation, and cross-curricular project ideas to better integrate SDGs. They also expressed the need for a platform for sharing best practices and resources.

Conclusions

The focus group discussions conducted in Poland, Estonia, Spain, Latvia, and Greece yielded informative insights for the "STEAM in SDGs" project.

A critical finding is that while some educators are quite familiar with the Sustainable Development Goals, many have limited knowledge or experience integrating them into STEAM subjects. This suggests an immediate need for comprehensive educational initiatives to raise awareness and understanding of SDGs among teachers.

There is a clear necessity for targeted professional development programs. These programs should focus on providing teachers with the necessary tools and methodologies to integrate SDGs into various STEAM disciplines effectively. This would help overcome the noted challenge of making the SDGs relevant and engaging to students, particularly in disciplines where the connection isn't immediately obvious.

The discussions highlighted both challenges and opportunities within the current curricular frameworks. Teachers pointed out the difficulty in embedding SDGs into existing curricula, often due to a lack of flexibility within the educational system or sufficient materials that bridge STEAM subjects with these global goals. Opportunities lie in the ability to develop interdisciplinary projects and learning models that can make education more relevant to global challenges.

The focus groups underscored that when SDGs are integrated into STEAM education, students exhibit increased engagement and a greater ability to relate classroom learning to real-world issues. This positive impact highlights the potential of SDGs to make STEAM education more meaningful and underscores the importance of implementing such educational strategies.

A consistent theme across countries was the need for more resources—both in terms of materials and infrastructural support. Ready-to-use lesson plans, examples of best practices, and access to technological tools, including AR and computer modeling, were frequently cited as necessary for enhancing the delivery of SDGs in STEAM education.

Teachers expressed a desire for more collaborative platforms where they can exchange ideas, share success stories, and access peer support. The development of a community around STEAM and SDGs would foster a collective effort towards these educational goals.

Finally, the findings from the focus groups provide critical feedback for the ongoing development and implementation of the "STEAM in SDGs" project. The educators' insights have established a need for the project to:

- Facilitate a closer alignment between STEAM education and SDGs.



- Develop clear, adaptable strategies for teachers to integrate SDGs into their lessons.
- Provide resources that are accessible and applicable across diverse educational settings and age groups.

The "STEAM in SDGs" project must take into account these varied needs and perspectives to build a framework that supports teachers, engages students, and ultimately, fosters an educational environment conducive to achieving the SDGs through STEAM disciplines. The educators' willingness to participate and improve their practices is a positive sign, indicating a strong foundation upon which the project can build and expand.

Annexes: National Focus Groups by country

Poland - Szkoła Podstawowa nr 2 w Proszowicach

Objective:

The objective of the focus group is to gain a comprehensive understanding of teachers' perspectives, needs, and awareness regarding the integration of Sustainable Development Goals (SDGs) into Science, Technology, Engineering, Arts, and Mathematics (STEAM) classes.

Participants:

Primary school No 2 in Proszowice is a municipal school of national curriculum with an innovative English language program of teaching. Our school represents a typical cross-section of the Polish education system with about 400 students and 39 teachers. In the school there are 9 STEM teachers, two Biology, Chemistry, Physics and two Geography teachers, one History and one Social Studies teacher, three English teachers and three Polish language teachers. The meeting was conducted by Mrs. Izabella Krzywkowska who is an English teacher.

Activity implementation:

The meeting was held on the premises of Primary School No 2 on 22 March 2024 and it lasted 45 minutes. The leader of the meeting, who is also the coordinator of the project, introduced the core topic of SDG in STEAM and the idea of "learning by design". In the PP presentation all aspects of the Erasmus+ project were shown and discussed. The teachers were asked to take notes and dot down the remarks which proved to be useful for further discussion. Following the content presentation, the group had a collective discussion which due to long, practical experience in education of all participants, was particularly interesting and thought provoking. Finally, the Google Forms questionnaire was completed by all teachers present at the Focus Group meeting.

Findings:

Demographic Information:

For the sake of the focus group analysis, 7 teachers (5 female and 2 male) were chosen, representing the following subjects:

- | | | |
|-------------------------------------|------------------------|----------------------------|
| · Math - grades 4-8, | 32 years of experience | Mrs Iwona Wojtasik |
| · Physics /Chemistry - grades 7-8 , | 12 years of experience | Mrs Dorota Świątek - Grzyb |
| · Biology - grades 5-8, | 20 years of experience | Mrs Halina Warso |
| · Geography - grades 4-8, | 18 years of experience | Mr Wojciech Musiał |
| · History - grades 4-8 | 30 years of experience | Mrs Iwona Marzec |
| · Art - grades 3-8 | 8 years of experience | Mrs Karolina Barnaś |
| · IT - grades 3-8 | 12 years of experience | Mr Krzysztof Chmura |

Awareness and Understanding:

How familiar are you with the concept of Sustainable Development Goals (SDGs)?

- 1 teacher was very well informed about SDGs as it is part of curriculum
- 2 teachers were quite familiar with SDGs
- 4 teachers were not quite familiar but they realized it is connected with preserving ecosystems and well-being of people

On a scale of 1 to 5, how comfortable do you feel integrating SDGs into your STEAM curriculum?

- The average was 3.

Integration into Curriculum:

How do you currently integrate SDGs into your STEAM curriculum, if at all?

Most teachers, even if they are not so familiar with all the 17 Sustainable Development Goals, still integrate some of them into their curriculum or they are being integrated as a part of the educational mission of the school in charity and ecological actions. The most substantial amount of SDG topics is incorporated into Biology curriculum, both all the 17 goals are presented in the textbooks plus some of the topics are extensively explored, like water circulation, sea life, animals, healthy lifestyle, and ecological approach. Geography and Art are also implementing some of the goals, but they are not clearly defined as SDG – they are simply part of the curriculum – demography and hunger, climate, forests etc. On the school premises we also have a UNICEF unit run by the History teacher and its actions promote many SDGs. In Poland once a week the class-form tutor has a lesson called Formation Class. During this lesson each class-form teacher discusses important topics with students, and this is also an excellent opportunity to incorporate such questions like equality of sexes in career paths, consumption and sustainability, ecological approach in everyday life, and the importance of good education.

Are there specific STEAM disciplines where you find it easier or more challenging to incorporate SDGs?

The biggest concern connected with incorporating SDGs into curriculum was expressed by Maths and Chemistry/Physics teachers who find such topics difficult to justify in their everyday schoolwork. They can see only a few SD Goals possible to mention and they may even seem a bit over stretched.

What challenges do you foresee in fostering students' interest in both SDGs and STEAM disciplines?

Generally, teachers from the focus group do not foresee any major challenges in fostering students' interest in SDGs. They argue that the goals themselves are a natural and obvious way to improve peoples' and animals' lives on the planet therefore raising interest and involvement should come naturally. However, we need to be extra cautious as far as young people's mentality and fragile personalities are concerned. We need to avoid drastic examples, exaggerated numbers, pictures, and video clips so as not to raise radical emotions like doom-like sadness or anger expressed by devastation or self-hurting so visible among eco-activists/terrorists nowadays.

Learning by Design Approach:

Have you used a "learning by design" educational approach in your teaching? If yes, how?

The teachers all agreed that so far, they had used the learning by design approach however in a limited scope, mainly due to the lack of pre-prepared ideas, resources, and materials and because of scarcity of class-time.

Practical ideas the focus group gave were as follows:

- Math – designing and making paper polyhedrons.
- Physics /Chemistry – design of electrical current device
- Biology – frequent projects on ecology, healthy lifestyles
- Geography – volcano design with experimental eruption
- History – historical fashion project
- Art – frequent art tasks based on designing
- IT – using 3D printer

If yes, how do you think this approach aligns with teaching SDGs in STEAM?

The answers differed a little, but the teachers generally believed the SDGs could be successfully incorporated into STEAM curriculum, providing the topics are presented in an involving, captivating way. First of all, students need to be engaged in the content of the lesson and here the methodology plays the main role. It would be much easier if teachers were offered ready-made, pre-prepared, easily obtainable resources which could be used during the lesson. A few teachers pointed out that we need to be extra careful not to ridicule the whole idea by forceful implementation of SDGs into subjects which are not really cut out to follow such topics. One teacher noticed that CLIL was a good concept for introducing extra content into language teaching and that it would be a good idea to use foreign language teaching for SDG-content oriented texts.

Professional Development Needs:

What kind of professional development or support do you feel would help you better integrate SDGs into your STEAM teaching?

- inside trainings
- professional resource materials
- better equipment
- knowledge on the core subject
- supervising educational board support and allowance

Are there specific areas related to AR technology or the "learning by design" approach where you would like additional training?

All the given answers were YES or RATHER YES which suggests the awareness of the gap in this area in both knowledge and resources available.

Student Impact:

Can you share any experiences of how teaching SDGs in STEAM has positively impacted your students?

- students got more involved in the subject as they felt connected to the core subject knowing that it is a part of a bigger idea.
- students understand the content better thanks to numerous examples available in the internet
- students got more involved into important topics for humanity

What challenges, if any, have you observed in students' understanding or engagement with SDGs?

- some students remained indifferent even if the topic touches the vital problems of the planet (Biology, Geography)
- students worry if the content of extra topics do not interfere with basic content which needs to be covered and trained for the final exams (Math, History, English)
- some students may find it hard to capture the topic like hunger, poverty, industry or education for artistic purposes (Art)
- some students may find it boring and irrelevant (Physics, History)

Suggestion and Feedback:

What additional resources or support would you find helpful in teaching SDGs in STEAM classes?

- lesson plans
- practical resources in form of presentations, worksheets that can be easily downloaded
- software to teach SDGs in STEAM
- ideas how to conduct a discussion – questions, opinions etc.
- ideas for Oxford Debate on the topics
- ideas for inviting inspiring guest to school acting as role models.

Any suggestions or feedback on how the STEAMinSDGs project can better assist teachers in this context?

- it can strengthen the position of the teacher showing him/her as an innovative educator
- it can bring practical, hands-on resources
- it can be eye-opening on new ideas, problems and topics



Conclusions:

The Polish focus group decided that the idea of SDGs incorporated in STEAM looks like a very promising educational opportunity providing some innovative materials and online resources available for teachers. We need to awaken the awareness in students' minds however it must be done in a proper way using positive materials and emotions, be captivating and should not interfere with the core material important for final examinations. Providing teachers with training and resource materials seems to be crucial.

Estonia - Tamsalu Gymnasium, Estonia

Objective:

The objective of the focus group is to gain a comprehensive understanding of teachers' perspectives, needs, and awareness regarding the integration of Sustainable Development Goals (SDGs) into Science, Technology, Engineering, Arts, and Mathematics (STEAM) classes.

Participants:

Tamsalu Gymnasium is a municipal school – the number of staff: 51 teachers (primary school, middle school, and high school)

Activity implementation:

The group work lasted for 60 minutes, during which the project idea was introduced and there was a collective discussion on integrating sustainable development goals into natural sciences, mathematics, and arts. Following that, participants responded to a pre-prepared questionnaire (Google Forms). Subsequently, the responses were collected into a shared document and presented as a focus group report.

Findings:

1. Demographic Information:

Grade/Subject(s) taught:

- Craft and Technology, Handicrafts, and Home Economics: Grades 4-8
- Elective Course: Fashion Course: Grades 10-12
- Natural Sciences, Geography, Biology, Chemistry, Physics: Grades 7-12
- Art Education: Grades 5-9
- Mathematics: Grades 5-11
- Economics and Entrepreneurship: Grades 10-12
- Computer Science: Grades 5-6
- Years of teaching experience: 2-42 years (average 19.5 years)

2. Awareness and Understanding:

How familiar are you with the concept of Sustainable Development Goals (SDGs)?

- I am aware;
- Rather aware;
- To a small extent;
- I don't know anything;
- I have no previous exposure to the concept of Sustainable Development Goals;
- I am familiar with the SDGs;
- As I have participated in one previous project and additionally have been guiding the Artmile project for the fifth year, which is based on these goals;
- I am quite familiar;
- I am well-informed.

On a scale of 1 to 5, how comfortable do you feel integrating SDGs into your STEAM curriculum?

- average - 2

3. Integration into Curriculum:

How do you currently integrate SDGs into your STEAM curriculum, if at all?

- To a small extent.
- Often, recycling of fabrics and similar materials is used.
- And I have also introduced it to students to some extent.
- I do not consciously integrate.
- I do not consciously do it, but looking back, the methodology has been used, albeit randomly.
- I do not consciously integrate.
- Currently, I am guiding the Artmile project in the 8th grade, which is based on SDGs.
- I have not dealt with this topic consciously.
- I do not consciously integrate specifically; many topics are related to educational activities anyway (quality education and equal opportunities regardless of gender are the basis for many other topics)

Are there specific STEAM disciplines where you find it easier or more challenging to incorporate SDGs?

- I don't know.

- Recycling.
- It could be perhaps technology, which is related to design.
- Simplifying natural sciences to the level of models, to make it tangible and visible.
- I don't know how to answer.
- I can't say.
- Quality education is paramount depending on the teaching process, and real-life examples can be provided for almost all topics - although it's difficult to directly tie them to the curriculum.

What challenges do you foresee in fostering students' interest in both SDGs and STEAM disciplines?

- Implementing computer technology for physical work.
- Some students find it easy, those who understand and comprehend.
- Others find it slightly challenging, but if there are accompanying benefits, it becomes easier.
- Perhaps practical involvement could help in generating interest.
- It's easy to maintain interest through playing and fiddling around but giving it meaning and solidifying new knowledge through play is essential.
- If the teacher is interested, they can also cultivate this interest in the students.
- It's generally difficult to cultivate interest in topics that don't interest students or seem unrelated to their lives.
- It will certainly be a significant challenge to generate interest in the students on this topic.
- It's becoming increasingly difficult to engage students with new topics - easily accessible entertainment on the internet kills interest and focus.

4. Learning by Design Approach:

Have you used a "learning by design" educational approach in your teaching? If yes, how?

- Yes, the students themselves design.
- Yes, I am, we make drawings and such. In the fashion course, we design clothes on paper.
- Yes, in technology. The design is part of the object design.
- Through participating in a project, yes, we built/invented an ice cream machine - what features the machine must have, what features the ice cream must have to be enticing - and how to achieve these physical properties with the machine.
- No.
- Probably, yes.
- I have encountered 3D printing.
- Yes, building robots (Lego) - programming. Creating 3D models (3dc.io) - printing.

If yes, how do you think this approach aligns with teaching SDGs in STEAM?

- Yes, it's in progress, as good groundwork leads to a better end result.
- Material costs and such are smaller, for example.
- When building-designing things, maybe think about how to achieve desired results with fewer resources - currently, most techniques for producing things burden the Earth's resources heavily.
- Generally, I think it fits, but it probably depends on the specific STEAM task.
- I think 3D modeling could develop spatial thinking.
- It depends on the SDG topic.

5. Professional Development Needs:

What kind of professional development or support do you feel would help you better integrate SDGs into your STEAM teaching?

- Computer modeling.
- IT support would probably be needed.
- It would be necessary to educate oneself in this field.
- Building models, what tools, what methodology to use for construction.
- Motivation to engage with it.
- I would like to start with basic knowledge of teaching STEAM.
- Since I have no prior experience, I need comprehensive training and support.
- Practical examples of integrating informatics education with SDG goals.
- More ready-made items. Things to showcase, things that need to be completed.

Are there specific areas related to AR technology or the "learning by design" approach where you would like additional training?

- Use of Augmented Reality (AR).
- More educational videos and similar materials.
- There is no experience in the field of Augmented Reality.
- It wouldn't be bad to receive training.
- Creating models on the computer to quickly visualize natural science processes.
- Augmented Reality technology in general.
- Examples of implementing AR technology, examples of applying methodology through design.

6. Student Impact:

Can you share any experiences of how teaching SDGs in STEAM has positively impacted your students?

- No, I can't.
- Knowledge learned through hands-on experience is closely related to everyday life, resulting in a better ability to connect learned knowledge with everyday life.
- Since the topics covered in my class are more applicable outside of school, it's difficult for me to assess its impact.
- If we consider only education, then some students have developed a serious interest in the field of computer science and have later become recognized specialists in their field.

What challenges, if any, have you observed in students' understanding or engagement with SDGs?

- I have not noticed.
- I don't believe that most students have any conception of the SDGs at all.
- In reality, it's difficult to make them believe in problems they don't encounter themselves, noticing problems and seeing the world beyond their local area.
- Since I haven't consciously dealt with the topic, I haven't noticed (but I will start working on it next week).
- One difficulty may be broadening the students' horizons, as many middle school students don't seem to be interested in it.
- Overall interest in the surroundings is poor, easily accessible entertainment on the internet sucks them in.

7. Suggestions and Feedback:

What additional resources or support would you find helpful in teaching SDGs in STEAM classes?

- Technological tools (hardware).
- Educational videos on various topics covered in different subject classes.
- Make textbooks more innovative and include items that are more contemporary.
- Pictures and other visuals of finished products; students should be given a clear idea of what the final product should look like. Emphasis on understanding the essence, linking practical knowledge to everyday life, and developing skills in creating models.
- Raise teachers' general awareness about implementing the SDGs (their nature, significance, etc.).
- Practical guidelines, examples, lesson plans/curricula.



- Resources and instructions for acquiring and implementing hardware (AR).

Any suggestions or feedback on how the STEAMinSDGs project can better assist teachers in this context?

- Comprehensive training.
- School-wide or cross-school level projects, project days, to integrate different subjects into a whole and involve more educators.
- Information minutes/hours/trainings for everyone (including the connection to the new curriculum).
- Practical guidelines, examples, lesson plans/curricula.

Conclusions:

The focus group members found that integrating the Sustainable Development Goals into the national curriculum is important. They also emphasized the need for training and guidance materials. All of them are willing and motivated to participate in the project, expand their knowledge, and professionally develop themselves through the project.

Spain - CEIP San Antonio & Formative Footprint

Objective:

The objective of the focus group activities is to gain a comprehensive understanding of teachers' perspectives, needs, and awareness regarding the integration of Sustainable Development Goals (SDGs) into Science, Technology, Engineering, Arts, and Mathematics (STEAM) classes.

Participants:

Twelve (12) teachers proficient in STEAM subjects have been invited by CEIP San Antonio to share their perspectives, needs, and awareness on the topic.

1. Pau Salvador Miralles, Physical education teacher.
2. Antonio Vicente (Headmaster) Primary School teacher and English teacher 5th level.
3. Alicia Boix Ruíz. Headteacher, Primary School teacher 3rd level and English teacher.
4. Maite Valverde, Primary School teacher and English teacher 4th level.
5. Tamara Mateu, Primary School teacher 3rd level and English teacher.
6. Carmen Chicote, Religion teacher.
7. Patricia Gallego, Primary School teacher 5th level.
8. Pascual Magín Follana Ramón. Primary School teacher 4th level.
9. Almudena Marínez Álvarez Primary School teacher 5th level and English teacher.

10. Alejandro Durá Cortes Primary School teacher 6th level. 11. Francisco López Díez Primary School teacher 6th level. 12. Paqui Vázquez Sánchez Primary School teacher 3rd level.

Activity implementation:

Our school is called CEIP San Antonio. It is located specifically in the hamlet of La Hoya, a town 5 kilometers from Elche.

Our students are mostly locally born. In general, we observed students who were motivated to learn and were fully immersed in the use of new technologies. We currently have 312 students. 73 are in preschool (3-5 years old) and 239 students are in primary school (6-12 years old).

We want to encourage motivating learning in them, and investigate effective strategies to integrate the SDGs into STEAM classes (The STEAM competition aims to equip students with practical, "future-ready" skills by focusing on teaching science, technology, engineering, and

math, but also fosters a love of creativity and imagination by bringing the arts into the equation.

We are aware that:

- Mathematical competence and competence in science, technology and engineering involves understanding the world using scientific methods, mathematical thinking and representation, technology and engineering methods to transform the environment in a committed, responsible and sustainable way.
- Mathematical competence allows you to develop and apply mathematical perspective and reasoning in order to solve various problems in different contexts.
- Competence in science entails the understanding and explanation of the natural and social environment, using a set of knowledge and methodologies, including observation and experimentation, in order to ask questions and draw evidence-based conclusions in order to be able to interpret and transform the natural world and social context.
- Competence in technology and engineering includes the application of the knowledge and methodologies of the sciences to transform our society according to the needs or desires of people within a framework of safety, responsibility and sustainability.

Moderator's Guide:

1. Demographic Information:

- Grade/Subject(s) taught:
 - Primary education: Mathematics, Science, Valencian language, Spanish language, English, Physical Education, Religion.
- Years of teaching experience:
 - Teaching experiences: 26, 24, 23, 10, 9, 8 years.

2. Awareness and Understanding:

- How familiar are you with the concept of Sustainable Development Goals (SDGs)?

- Our school contemplates an Educative Innovation Program where Teachers put in to practice these SDGs in class, within our daily Teaching Schedule. We also have attended to other Erasmus Projects where SDGs have been the main topic.

- On a scale of 1 to 5, how comfortable do you feel integrating SDGs into your STEAM curriculum?

- In a scale from 1 to 5, we consider that getting both SDGs and STEAM to convert is difficult to achieve.

- We consider to grade on a 4, as it's complicated to combine both aspects in some areas.

3. Integration into Curriculum:

- How do you currently integrate SDGs into your STEAM curriculum, if at all?
 - They are integrated inside the area of Interdisciplinary Projects, although they are also integrated as a transversal topic in all areas.

- Are there specific STEAM disciplines where you find it easier or more challenging to incorporate SDGs?

- It is easier for us to integrate the SDGs in science, in the areas of language and in art. In Mathematics it is more difficult for us to relate it.

- What challenges do you foresee in fostering students' interest in both SDGs and STEAM disciplines?

- Become aware of the problems related to your immediate environment or your life, such as saving water, protecting biodiversity, using clean and renewable energy.

4. Learning by Design Approach:

- Have you used a "learning by design" educational approach in your teaching? If yes, how?

- Yes we have to raise awareness about the use of water, the protection and conservation of the seabed, along with the main mathematical principles, we have created a boat using a 3D printer whose PLA filaments are formed from remains left over from production of rice. Therefore it is a sustainable print. Furthermore, within the science area, buoyancy has been worked on.

- If yes, how do you think this approach aligns with teaching SDGs in STEAM?
- Reusable material, reduce waste and use other non-polluting materials, thus contributing to the non-loss of biodiversity. Promoting sustainable development and a correct balance.

5. Professional Development Needs:

- What kind of professional development or support do you feel would help you better integrate SDGs into your STEAM teaching?
- Reduction of ratios, more human resources, more professionals talks, visiting other centers and exchanges to learn from other points of view and with other characteristics different from ours. In this sense, Erasmus projects are very interesting when it comes to exchanging perspectives between different centers, countries and cultures.
- Are there specific areas related to AR technology or the "learning by design" approach where you would like additional training?
- We would be interested in looking for speakers trained in AR, design, 3D printing... to be able to bring it to the classrooms. Getting in touch with other centers that tell us about these experiences and their experience in these areas, as well as Erasmus projects related to these topics. It is very interesting to exchange experiences.

6. Student Impact:

- Can you share any experiences of how teaching SDGs in STEAM has positively impacted your students?
- A good example and a positive experience to mix the SDGs with STEAM has been to create an annual meeting between different associations to CLEAN and REFOREST our beaches and Sierra del Molar, in La Marina. It is already our V edition.



- What challenges, if any, have you observed in students' understanding or engagement with SDGs?

- We have observed that more and more students are joining to the challenges. It is enough to propose them and they themselves ensure that the dissemination and impact reaches to different groups. They love to share on social media and they want to obtain people's likes. Every time we do an event that requires collaboration, we have encouraged greater



participation among students. It is true that our students are more aware of the SDGs every year.

7. Suggestions and Feedback:

- What additional resources or support would you find helpful in teaching SDGs in STEAM classes?

- Human resources, material and financial aids.

- Any suggestions or feedback on how the STEAMinSDGs project can better assist teachers in this context?

- Sharing experiences in different centers, contribution of ideas, sharing teaching practices, research and promoting interest among the students.

Latvia - Latvijas Universitate

Objective:

The objective of the focus group is to gain a comprehensive understanding of teachers' perspectives, needs, and awareness regarding the integration of Sustainable Development Goals (SDGs) into Science, Technology, Engineering, Arts, and Mathematics (STEAM) classes.

Participants:

Number and profile of the organization's staff.

The focus group discussion was moderated by Anny Kvelde, a project representative from the University of Latvia, a PhD student in education science. It is important to underline that the dissertation topic is related to the implementation and integration of SDG themes in learning processes. Anna has led several focus groups both within her dissertation research and as a participant researcher in other projects and studies.

- Number and teachers: 7 teachers from Riga primary school Rīdze participated in the study.
- Respondent group: 7 women.
- Subjects represented: *Physics, Mathematics, Chemistry, Biology, Science, Geography, Social Studies, Design, History.*
- Five teachers teach only one subject, while 2 teachers teach two of the above subjects: a) *Science and Geography*, b) *Social Studies and Design*.
- Respondents' experience of working in a school:
 - 1 teacher 0-3 years
 - 1 teacher 3-5 years
 - 2 teachers 5-10 years
 - 2 teachers 10-15 years
 - 1 teacher more than 15 years
- Education level of respondents:
 - 4 teachers have a Bachelor's degree in pedagogy
 - 3 teachers have a Master's degree in pedagogy or educational management
 - Continuously improve their knowledge through refresher courses, conferences, and forums.

Activity implementation:

The discussion lasted 1 academic hour or 40 minutes, as part of a methodological morning on 28.02.2024. The answers were not specific at the beginning, but as the discussion progressed

they remained specific, it is important to note that the national teaching materials do not mention the SDGs deliverables, so the moderator provided information on them to enable the teachers to understand the topic of the discussion in more depth. Some were seeing the UN SDGs for the first time, but in practice they integrate the related topics very actively.

Findings:

Report the answers to each question or block of questions as a pointed list, with into brackets numbers indicating the same results provided by different people. Follow the example below.

1. Demographic Information:

A brief overview of the primary school: in the school year 2023/2024, 75 teachers and 544 pupils study at Primary School Rīdze. The main priorities of Primary school Rīdze are digital education and SMART pedagogy, cultural heritage, mathematic and scientific research, international cooperation and democratic and respectful approach.

Primary school Rīdze school's management is focused on digitalization, international cooperation and teamwork.

2. Awareness and Understanding:

1. Curriculum integration: Riga Primary School is being integrated into the STEAM education curriculum. This integration will include practical activities, projects and interdisciplinary approaches in teaching different subjects.

2. Teacher Training: The level of awareness and understanding of STEAM among teachers varies. Some teachers have partially taken refresher courses or obtained a master's degree when the teaching process was discussed, which allows them to effectively integrate STEAM principles into their teaching practice. However, other teachers have limited experience or training in this area due to the lack of methodological teaching materials and developed tasks in these subjects.

3. Resources and support: Primary school has minimal available resources, as well as VISC (State Educational Content Center) or Skola2030 (education reform, which is based on the integration of cross-cutting competencies in the teaching process, <https://www.skola2030.lv/lv>) support for STEAM education, which stagnates awareness and understanding of it. Schools have started initiatives, within the framework of the Erasmus+

project funding has been planned to promote access to learning materials (<https://datorium.eu/lv>) for better preparation for the effective implementation of STEAM initiatives.

4. Community involvement: The school started purposeful interdisciplinary cooperation, more actively involving teachers in projects where STEAM education can be learned. Builds closer collaboration with local businesses, universities, and STEM-related organizations by providing additional resources, knowledge and opportunities for students to engage in learning STEAM concepts outside of the classroom.

5. Government initiatives: Government policies and initiatives aimed at promoting STEAM education in schools play an important role. Supportive policies, funding allocations and curriculum guidelines that emphasize STEAM principles contribute to increased awareness among primary school stakeholders. At the moment, few virtual tasks for students are created at the national level, STEAM educational informational materials are created on the basis of projects in cooperation with universities, but they are not offered purposefully to a wide range of teachers, for example, <https://iic.lv/projekti/steam-instruments-competence-approaches-to-development/>, but only 3 schools are involved.

Awareness and understanding of STEAM has been observed among respondents, and efforts to promote interdisciplinary learning, hands-on research, and problem-solving skills have been emphasized to prepare students for the demands of the 21st century workforce. On the other hand, professional development of teachers, investments in resources and cooperation between schools and public institutions are needed to improve the accessibility of STEAM education.

3. Integration into Curriculum:

The integration of STEAM education in the curricula of Latvian educational schools is different, depending on the specific school, available resources, and educational policy. Examples are that they are being integrated into the Primary School in Riga, but some initiatives have only just begun.

1. Interdisciplinary Projects: Teachers develop interdisciplinary projects that incorporate elements of science, technology, engineering, art, and mathematics. For example, students could work on projects such as designing and building model bridges (engineering and math), conducting experiments to study environmental issues

- (science), and creating digital presentations or animations to communicate findings (technology and art).
2. STEAM extracurricular activities: the school offers interest education groups focused on STEAM subjects, such as a lego group, computer graphics, a master workshop on design items, "Do it yourself!" (<https://www.ridze.lv/pamatskola/radosas-industries/>) These clubs and activities provide opportunities for students to explore their interests in areas such as robotics, coding, creative arts, and scientific research outside of the regular curriculum.
 3. Rooms and laboratories: The school has set up some rooms and two laboratories equipped with tools, materials and technologies to support hands-on research and experiments in all STEAM disciplines. These spaces allow students to engage in project-based learning, inventing, and collaborative problem-solving.
 4. Integration into existing subjects: STEAM concepts and principles are integrated into existing subject areas such as mathematics, science, and technology. For example, a science lesson on ecosystems incorporates elements of art by having students create visual representations of different habitats. Likewise, mathematics lessons on geometry include activities such as designing and constructing geometric shapes using engineering principles.
 5. Cooperation with external organizations: The school cooperates with external organizations such as museums, universities, and companies, providing students with access to knowledge, resources and real-world applications of STEAM concepts. It has been observed that these partnerships improve the learning experience and reveal diverse career paths in STEAM fields to students, cooperation in strengthening, Career Week and STEAM-related activity events are organized by the Career Counselor, in cooperation with the methodologist, the teachers' council and STEAM field educators.

Incorporation of STEAM education into the curriculum through the above and other approaches has been observed.

4. Learning by Design Approach:

The teachers actively use the Learning by Design approach, combining inquiry-based learning with project-based activities, promoting creativity, problem-solving skills and interdisciplinary collaborations. Below are examples shared by the teachers.

1. Identifying real-world problems: The approach helps students identify authentic problems or challenges that apply to their local community or environment. For example, students (grades 6-9) were assigned to research ways to reduce the amount of plastic waste in their school or to create a more efficient recycling system in their neighborhood.
2. Project-based learning: Students engage in hands-on projects that apply STEAM concepts to solve complex problems. For example, students designed and constructed

models of greenhouses (grades 7-8) to explore environmental science, engineering, and math concepts while addressing issues related to food production and sustainability.

3. Inquiry-Based Research: Students (grades 7-9) were assigned to conduct research and collect data to investigate phenomena related to their project topics. For example, students researched the effects of pollution on local waterways or researched the life cycle of plants in their school garden.

4. Integration of STEAM Disciplines: Projects/Collaborations are designed to integrate concepts and skills from multiple STEAM disciplines. For example, a project focused on the design and module construction of central squares (or palaces, historical eco-complexes) of Latvian cities included concepts of geometry and measurement (mathematics), principles of structural engineering (engineering), safety and accessibility considerations (technology) and creative design elements (art). 7 city modules were created; Riga, Kuldiga, Rezekne, Cesis, Bauska, Ventspils and Jelgava

Among the teachers is the use of the Learning by Design approach in STEAM education, which empowers students to become active learners, critical thinkers, and innovators, equipping them with the skills and knowledge needed to tackle complex challenges in their future careers and lives.

A bigger negative factor is the lack of time to prepare for such projects and the teachers' understanding of their approach to joint interdisciplinary projects has not been established, this is not determined by the school's culture, so it is mostly based on the teachers' own initiative, in turn, the teachers recognize this it is necessary to popularize the approach by developing and promoting the availability of methodical materials, this approach would be relevant for elementary schools as well, but especially useful for schools of grades 6-8.

5. Professional Development Needs:

It has been observed that teachers do not have access to materials to integrate SDG topics more effectively into STEAM subjects, they are not developed. Some virtual/digital tools have been created, but mostly in English.

Part of the respondents mentioned that they themselves study the sources, examples, cooperation with another student, then come up with the tasks together, but it takes time. Another teacher emphasized the fact that teacher courses on SDG topics for STEAM teachers were also not implemented, although after the discussion it was concluded that many lessons and topics are closely related to the majority of the 17 SDGs.

The teachers also had a little discussion about whether STEM or STEAM is more popular in Latvia because Art is a very important aspect. The primary school in Riga has a wide range of educational interests, a support team has been formed and methodical mornings are held once a week, teachers are involved in Erasmus projects and participate in other projects, such as Eco School, so even if it is not possible to acquire new knowledge in courses, it is learned through interdisciplinary cooperation and activities between schools.

6. Student Impact:

Student' involvement in STEAM subjects is observed, the following are the ways in which teachers implement it:

1. Practical Experiments: Students engage in hands-on experiments and prototyping to test their ideas and solutions. For example, students experimented with different materials and designs to create a model of a wind turbine.

2. Reflection and repetition (process monitoring) students reflect on their progress, challenges and discoveries. They revise their designs and strategies based on feedback and new insights gained through the iterative process. For example, students can reflect on the efficiency of their water filtration system and brainstorm improvements based on their observations and test results.

3. Authentic Assessment: Assessment focuses on students' ability to apply STEAM concepts in real-world contexts and effectively communicate their findings and solutions. For example, students created multimedia presentations and design exhibitions to showcase their projects to the school community and stakeholders.

7. Suggestions and Feedback:

The discussion highlighted the different sides of the teachers - the desire for innovation and creative approaches in the teaching process, the desire to develop and improve their knowledge of SDG and STEAM topics was found, and it would certainly be easier for teachers to learn the education of these innovations if teaching materials were developed.

New pedagogy programs teach both SDG and STEAM concepts, while those with 10+ years of experience do not have access to such knowledge if it is not purposefully acquired to improve performance.



Observed teachers' skill and motivation to cooperate. The teachers involve digital tools in the teaching process, the school has acquired tablets, but there are no programs/platforms developed for learning SDG and STEAM.

Conclusions:

The high motivation of the teachers makes STEAM education interesting, accessible to the student and focused on the development of cooperation and creativity/critical thinking. Unknowingly, teachers also integrate SDG topics, but this is based on self-initiative, not a national accessible education approach.

It has been observed that there is a lack of training materials to support teachers in more effective lesson preparation, teachers' workloads are increasing, and it is not easy to find much time for creating new tasks.

The teachers emphasize both the strengths of the teachers' collective and the fact that the new teachers and experienced teachers are encouraged to cooperate, and in recent years, the school has more and more new project ideas.

Greece - E-School Educational Group

Objective:

The objective of the focus group is to gain a comprehensive understanding of teachers' perspectives, needs, and awareness regarding the integration of Sustainable Development Goals (SDGs) into Science, Technology, Engineering, Arts, and Mathematics (STEAM) classes.

Participants:

Number and profile of the organization's staff.

Maria Malliora, a project partner from E-SCHOOL with a degree in Electrical and Computer Engineering (Meng), conducted the focus group discussion. She specialises in ICT-based learning, computational thinking, robotics, coding, and STEAM curriculum development. As a researcher on other projects and in the course of her dissertation research, Mrs. Malliora has presided over a number of focus groups.

Number and teachers.

Five males and **two** females representing various primary and secondary schools in the Karditsa region comprised the **seven teachers** who participated in the focus group.

Activity implementation:

The focus group lasted about 50 minutes and was hosted on the grounds of E-SCHOOL Educational Group. The participants were introduced to the project's concept, and the moderator then offered information on the UN SDGs and the "learning by design" approach to help them comprehend the topic of discussion in depth, as some were unaware of them. The group then had a collective conversation about how to include sustainable development goals into their regular subjects. Following that, participants completed a questionnaire (Google Forms), and subsequently their responses were collected into a shared document and represented in this document.

Findings:

1. Demographic Information:

- Grade/Subject(s) taught:
 - The subjects that the participants are teaching are *Mathematics, Greek Language, History, Science, Geography* and *Arts*.
- Year of teaching experience:
 - 3 teachers 5 – 10 years
 - 2 teachers 10 – 15 years
 - 2 teachers more than 15 years

2. Awareness and Understanding:

- How familiar are you with the concept of Sustainable Development Goals (SDGs)?

Most of the respondents were not so familiar with the concept of Sustainable Development Goals. 62% of respondents have only heard about the SDGs without being able to specifically define what they are, or how many there are. 20% of the respondents declared no previous exposure to the concept of the SDGs. Only one of the respondents has participated in a project, where she had to implement educational activities to promote the SDGs.

- On a scale of 1 to 5, how comfortable do you feel integrating SDGs into your STEAM curriculum?

Since their awareness of the SDGs is not significant, respondents' average degree of confidence in incorporating SDGs into STEAM curriculum is low, at around 1.14. However, the teachers indicated that with greater knowledge of the SDGs, they would be more at ease integrating them into their STEAM curriculum.

3. Integration into Curriculum:

- How do you currently integrate SDGs into your STEAM curriculum, if at all?

The teachers' answers indicate that they are not consciously integrating the SDGs into STEAM curriculum, but they do so unconsciously by conducting experiments and educational activities that promote sustainable practices and environmental conservation/waste management and are thus consistent with the concept of the SDGs.

- Are there specific STEAM disciplines where you find it easier or more challenging to incorporate SDGs?

The majority of the respondents believe that integrating SDGs into Science lessons would be easier, as topics such as conservation, biodiversity, and climate change align closely with SDGs related to environmental sustainability. Another lesson that they think would be easy to introduce the SDGs would be Mathematics, since they can easily create activities that reflect real-world problem-solving, where students have to analyze data and provide a sustainable solution.

The lesson they thought to be more difficult to integrate into the SDGs is Arts, because for them it was a bit challenging to find a connection between artistic activities and sustainability topics.

- What challenges do you foresee in fostering students' interest in both SDGs and STEAM disciplines?

According to the respondents, a major setback would be the limited access to appropriate educational materials and resources to effectively teach about the complex topics and issues involved in STEAM education. Moreover, many of them mentioned that the existing curriculum may not prioritize or provide sufficient flexibility to incorporate discussions and activities related to SDGs alongside STEAM subjects. Lastly, all the respondents agreed that teachers require additional training and professional development to be able to engage students in meaningful learning experiences.

4. Learning by Design Approach:

- Have you used a "learning by design" educational approach in your teaching? If yes, how?

Almost all the teachers have used the “learning by design” approach, especially during the “Skills Workshops”, which is new mandatory aspect of the curriculum in Greece. During the “Skills Workshops” the students have to explore and develop solutions for real-world problems through inquiry-based learning. These hands-on projects and collaborative tasks help teachers encourage students to apply STEAM concepts to address issues related to sustainability, while also fostering the development of skills, such as problem-solving and critical thinking.

- If yes, how do you think this approach aligns with teaching SDGs in STEAM?

The conversation showcased that the teachers believe that the “learning by design” approach aligns well with teaching Sustainable Development Goals (SDGs) in STEAM education. They mentioned that inherently engages students in identifying and addressing real-world problems or challenges, providing meaningful context and relevance to the SDGs' global goals. By encouraging interdisciplinary solutions drawing upon knowledge and skills from multiple STEAM disciplines, students see the interconnectedness of different subject areas in tackling complex global issues. Moreover, the hands-on, experiential learning experiences fostered by both approaches promote deeper understanding, creativity, critical thinking, and collaboration, essential skills for the future. Designing and prototyping solutions to real-world challenges related to the SDGs, students actively engage with the content, empowering them to become agents of change.

5. Professional Development Needs:

- What kind of professional development or support do you feel would help you better integrate SDGs into your STEAM teaching?

From the teachers’ responses it is evident that training sessions focusing on understanding the SDGs are essential to provide them with a solid foundation to integrate them into their everyday teaching. In addition, access to resources such as lesson plans, ready-to-use teaching materials, and case studies on successful implementation in the classroom would greatly facilitate their integration into their STEAM teaching. Finally, some of them mentioned that support and mentorship from experienced educators/trainers or even networking opportunities with those who specialize in the topic would help them get personalized guidance on the proper integration of SDGs in STEAM education.

- Are there specific areas related to AR technology or the "learning by design" approach where you would like additional training?

All the respondents expressed a desire to receive additional training to both AR technology and the "learning by design" approach. Regarding the AR technology, they highlighted that there is a need for training mostly in creating AR-enhanced educational materials and activities. Additionally, they mentioned that guidance on how to effectively integrate AR technology into various subjects within the curriculum would be very useful. As for the "learning by design" approach, the teachers indicated an interest in receiving new techniques that will allow them to design and facilitate project-based learning experiences for their pupils.

6. Student Impact:

- Can you share any experiences of how teaching SDGs in STEAM has positively impacted your students?

Teachers were unable to relate specific experiences since they did not consciously integrate the SDGs into their STEAM lessons. However, after discussing the SDGs during the session, they realized that the majority of the SDG themes are part of STEAM education. They discussed the beneficial outcomes of the STEAM classes they have introduced thus far. Participating in hands-on projects and activities has helped students develop a variety of abilities, including problem-solving, critical thinking, and teamwork, as well as increased engagement and enthusiasm to investigate and discover real-world challenges. They have also gotten a deeper awareness of global issues, which has encouraged interdisciplinary thinking, empathy, and empowered them to be active agents of positive change in the world.

- What challenges, if any, have you observed in students' understanding or engagement with SDGs?

The teachers do not consciously integrate SDGs into their lessons, making it difficult for them to identify challenges and obstacles. They stated that it can be challenging to engage kids with issues that they do not face in their own communities and in their everyday lives.

7. Suggestions and Feedback:

- What additional resources or support would you find helpful in teaching SDGs in STEAM classes?

The respondents expressed the need for various resources and support to effectively incorporate the SDGs into the STEAM classes, as they have no previous experience of it. They believe that comprehensive guides or frameworks specifically designed to assist the integration of the SDGs should be readily available to provide them guidance, lesson plans and instructional strategies. Moreover, access to a variety of educational materials, such as books, videos and online resources that explain the SDGs and how they can be introduced to primary school curricula could be very helpful. Additionally, technology tools and resources, such as apps, multimedia presentations, and interactive materials can enhance students' understanding of the topics and facilitate engagement. Lastly, opportunities for professional development seminars and training sessions focused on the topic of teaching SDGs in STEAM can immensely help teachers.

- Any suggestions or feedback on how the STEAMinSDGs project can better assist teachers in this context?

The teachers emphasized the importance of comprehensive resources to provide them with both the theoretical background and practical guidance with clear instructions to facilitate their understanding of how to implement the SDGs in the classroom. In addition, they expressed that practical examples and step-by-step instructions would enable them to incorporate AR technology into their teaching to increase pupils' engagement. Lastly, they highlighted that guidance on developing their own structured plans and activities tailored to their classes needs would ensure an effective implementation of SDGs in STEAM education.

Conclusions:

From the above questions, we can infer that teachers are motivated to make STEAM education more accessible and introduce the concept of the SDGs through it. Teachers unconsciously incorporate SDG concepts, but only as part of the projects they carry out with their students to promote sustainability, as the SDGs are not part of the national education approach. It has been observed that there is a lack of training materials to assist teachers in developing lesson plans and activities designed to integrate the SDGs into STEAM education, and the demands on teachers are increasing, making it difficult to find time to create new activities. Their responses highlight the need for comprehensive guidance, training and ready-to-use resources to facilitate the integration of SDGs.



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2023-1-PL01-KA220-SCH- 000156257



Co-funded by
the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA).

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