G.A.
STEM

Enhancing STEM skills through Arts and mini-games

IO3 - OUTPUTS AND RECOMMENDATIONS ON ARTS AND MINI-GAMES IN STEM EDUCATION

Co-funded by the
Erasmus+ Programme
of the European Union

Erasmus+ Programme: KA2 - Strategic Partnership - School Education

G.A.STEM, Grant Agreement Number 2018-1-FI01-KA201-047215

Elaborated by	EU-Track in collaboration with all partners
Activity related	IO3/A4 Output on the best practices collected and recommendations.
Deliverable N° and title	IO3 – Outputs and Recommendations on Arts and Mini-Games in STEM Education

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1. INTRODUCTION

The present report describes the activities realized and the outputs reached during the piloting phase: training course in e-platform (for teachers) and study projects development (by students).

It analyses the results achieved as well as provides a comparison between the expected and the achieved results.

In detail, it describes the performances obtained by students in terms of knowledge, skills and competences developed, and exercises carried out.

The leader of this intellectual output is EU-Track (Italy). However, all partners, through the Piloting Team, have been involved:

- TURUN YLIOPISTO (Finland)
- Tamsalu Gymnasium (Estonia)
- TALLINN UNIVERSITY (Estonia)
- PIXEL Association (Italy)
- I.C. MARIA MONTESSORI (Italy)
- Sint-Lievenscollege Ghent (Belgium)
- Rieskalahteen Koulu (Finland)

Besides, this intellectual output provides the analysis of reporting logs on the project work realized, drawn up by teachers during the piloting phase. The reporting logs are analysed in terms of the shared experiences in European partnership, STEM and transversal skills developed by the students.

Finally, it contains the best practices implemented in the schools involved, the study projects developed by students, and a collection of recommendations underlining the strengths and weaknesses related to future implementation.

On the basis of the results achieved, the training path and the methodology will be updated and adjusted.

The tasks have been the following:

- O3/A1 - Teachers Training;
- O3/A2 - Development of study project with students;
- O3/A3 - Collection of the best practices;
- O3/A4 - Drawing up of the output on the best practices collected and recommendations for future implementation.

The whole piloting phase and the involvement of the target groups (teachers and students) were affected by the restrictions due to the pandemic, with some differences at national level in the partner countries involved: Finland, Italy, Belgium and Estonia.

To collect qualitative and quantitative data for the project tools and methodology evaluation, the Quality Assurance and Evaluation Team prepared and administered detailed instruments, as follows:

1. Pre-piloting online questionnaire for teachers (Annex 1);
2. Post-Training Teacher Questionnaire (Annex 2);
3. Preliminary Students Questionnaire (Annex 3);
4. Follow-up Questionnaire for students (Annex 4);

Besides, the teachers reported their experiences on the realized work with their students and the effectiveness of the project pedagogical approach through the reporting logs, using a template provided.

All the results were compared, analysed, processed and reported in specific sections of the current document.

2. ARTS and MINI-GAMES TRAINING

The “Arts and Mini-games” course involved teachers identified through a selection procedure started in February 2020 with the compilation of the application form (ANNEX 5). The Piloting Team gave special attention to teachers working in schools which have, among their priorities, mainly:

- Reduction and prevention of early school leaving;
- Promotion of equal access to education;
- Ability to provide teacher training as a real support;
- Reinforcing social inclusion and integration.

The Piloting Team looked over all the applications collected in the partner countries and compiled a selection grid. The enrolment priority was assigned in accordance with the date of applications’ arrival. However, the registration process has been opened till October 2020 to provide teachers, and, consequently, students with the opportunity to attend the training and to realize the project work with their students. This emergency factor was adopted by the team to deal with the national restrictions due to the COVID-19.

Anyway, the piloting training path was delivered to the teachers enrolled. They attended the four modules (Figure 1) from February 2020 to October 2020:

1. Improving STEM skills using the Arts;
2. Combining Arts and game for STEM;
3. Working with game mechanics and game concept;
4. The piloting phase: teachers training and student project work.

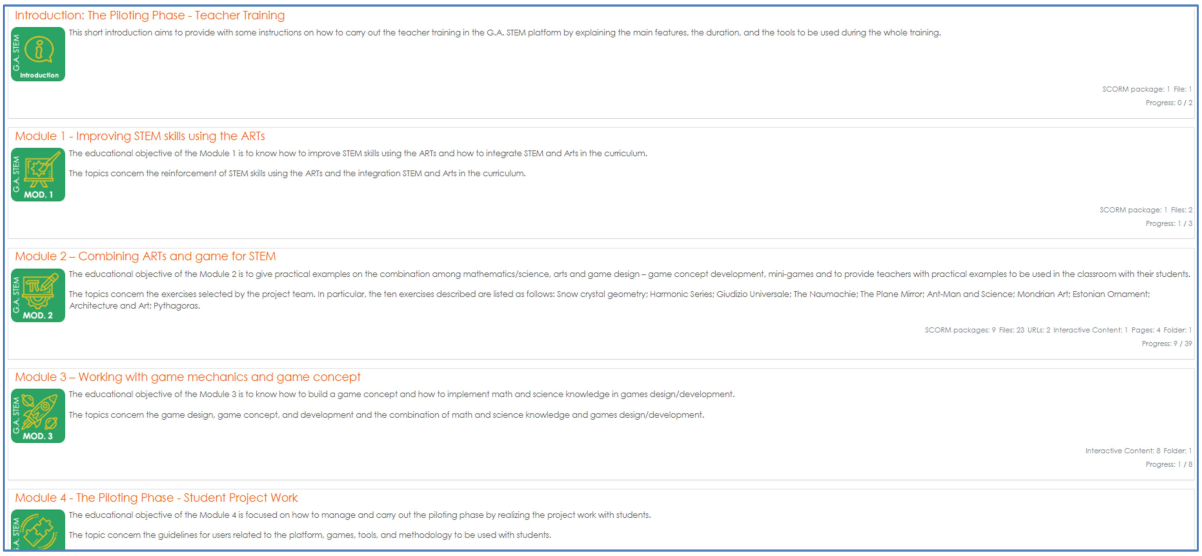


Figure 1 - The four modules of the “Arts and Mini-Games” course on the G.A.STEM Platform.

2.1 Teachers’ Profile Description

A total of 86 teachers enrolled in the “Arts and Mini-Games” course were from different countries (Figure2):

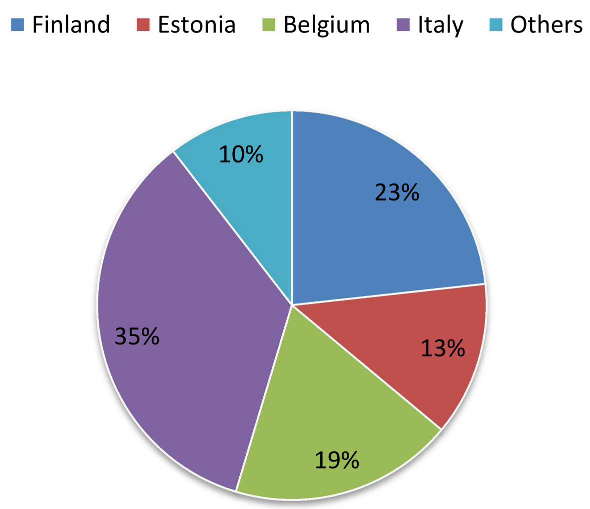


Figure 2 - Countries engaged in G.A. STEM training.
Others: Greece, India, Ireland, Portugal, Romania, Turkey.

During the online event held on April 15th in the framework of the 2020 STEM Discovery Campaign organized by SCIENTIX, the G.A.STEM project, including the piloting phase, was presented (Figure 3). This event allowed the Piloting Team to engage teachers also from other countries, different from the partner organizations, in particular, from Greece, India, Ireland, Portugal, Romania and Turkey.

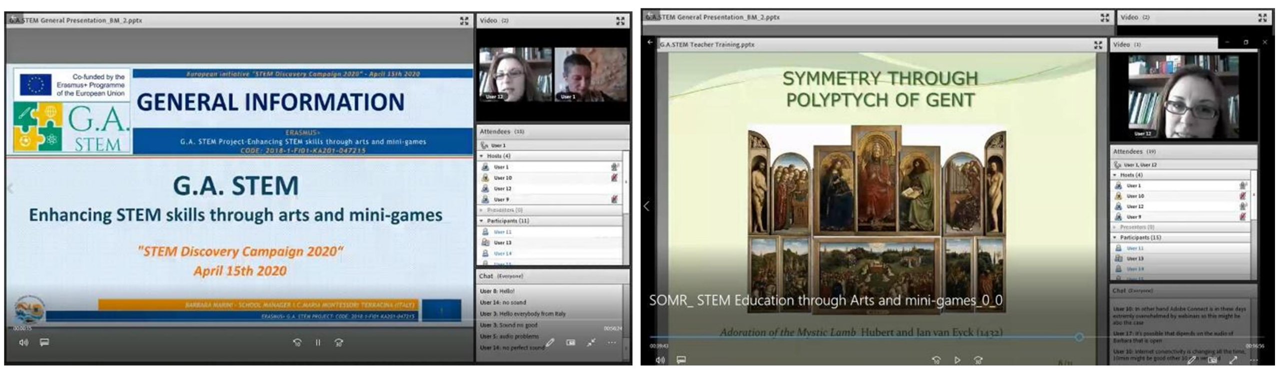


Figure 3 - G.A.STEM Project event organized during the *2020 STEM Discovery Campaign* by SCIENTIX.

Concerning the subjects taught, the majority of respondents have specified mathematics and physics (40%) and science (17,44%). However, as can be seen from Figure 4, the G.A. STEM methodology and tools proposed have attracted also teachers of other subjects, such as Art, Chemistry/biology, ICT, English and Socio-economics studies.

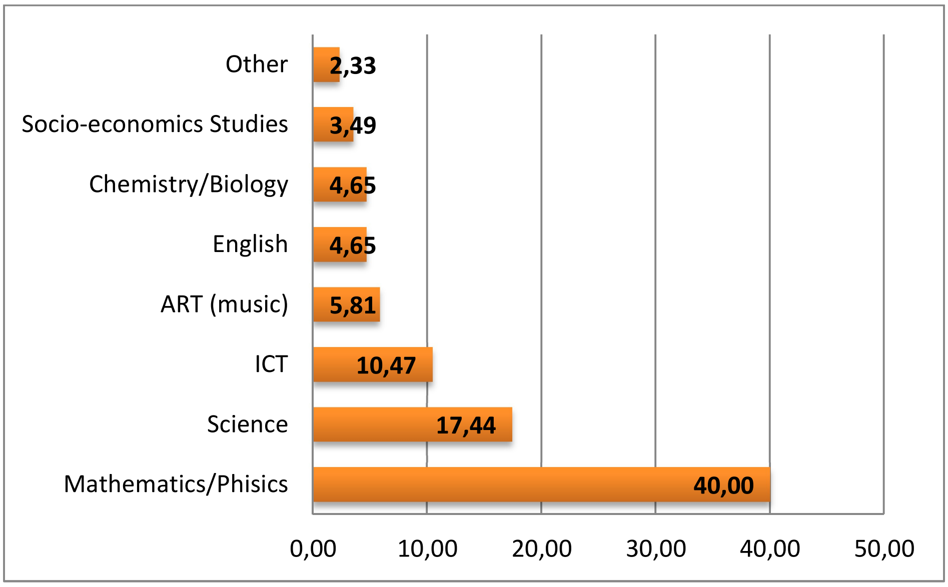


Figure 4 - Subjects taught by the teachers involved.

2.2 Teachers' Training Implementation

Before starting the piloting phase with their students, teachers were engaged in a training to provide them with a clear overview of the methodology and with awareness on the tools to be used with their students for the project work realization.

They could access the "Arts and Mini-games" course through the G.A.STEM platform (https://gastem.pixel-online.org/art-and-mini-games-course.php) and benefit from:

- A short introduction aiming to provide with instructions on how to carry out the teacher training in the G.A. STEM platform by explaining the main features, the duration, and the tools to be used during the whole instruction period. It included an instructional video on "How to navigate and use the G.A. STEM platform".
- **Module 1 - Improving STEM skills using the ARTs** to know how to improve STEM skills using the ARTs and how to integrate STEM and Arts in the curriculum. The issues regard the reinforcement of STEM skills using the ARTs and the integration of STEM and Arts in the curriculum.
- **Module 2 - Combining ARTs and game for STEM** aimed to give practical examples on the combination between mathematics/science, arts and game design/game concept development, mini-games and to provide teachers with practical examples to be used in the classroom with their students. The module contains the exercises selected by the project team. In particular, the ten exercises described are listed as follows: *Snow crystal geometry; Harmonic Series; Giudizio Universale; The Naumachie; The*

Plane Mirror; Ant-Man and Science; Mondrian Art; Estonian Ornament; Architecture and Art; Pythagoras.

- **Module 3 – Working with game mechanics and game concept** to know how to build a game concept and how to implement math and science knowledge in games design/development. The topics concern the game design, game concept and development and the combination of math and science knowledge with games design/development.
- **Module 4 - The Piloting Phase - Student Project Work** is focused on how to manage and carry out the piloting phase by realizing the project work with students. The topics present the guidelines for users related to the platform, games, tools, and methodology to be used with students.

Each module was composed of a multimedia lesson, lecture notes, PowerPoint presentations, videos and demos. Besides, for each game design development in Module 2, the project team realized a mini-game design example combining Arts and Mathematics/Science subjects by using the template (ANNEX 6 - Mini-game Concept Design Template) developed.

Teachers could share their experience and activities and communicate with each other through both international and national forums (Figure 5), established one per each country involved in the project. This section in the G.A.STEM platform was used by the national tutor to support them during the training and the piloting phase with their students for content and technical assistance.

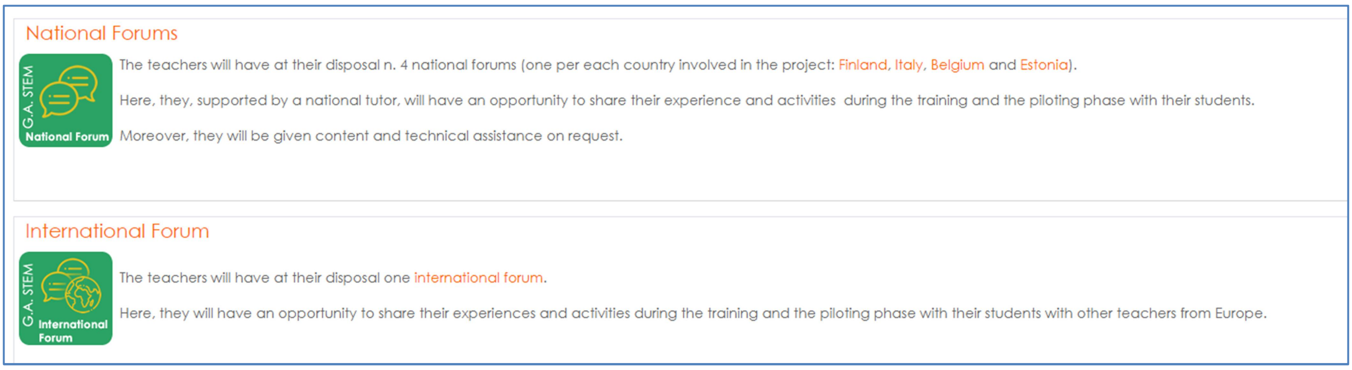


Figure 5 - National and international forum in the G.A. STEM platform.

Several online meetings were organized before, during and after the teachers' training to help them implementing the G.A. STEM methodology and tools (Figure 6).

Figure 6 – One of the online meetings organized with teachers during their training.

Before and after the training, teachers involved compiled the Pre-piloting online questionnaire for teachers and the Post-Training Teacher Questionnaire. In the end, the number of teachers, who have completed the training, was 62 against the initial number of 86 teachers registered to the course. This was caused by the pandemic restrictions, mainly for two reasons. First of all, some teachers were overworked with the management of virtual lessons and online activities to be done with their everyday classes. Secondly, the concerns of teachers not to be able to carry out the project work with their students in face-to-face modality. The teachers, who completed the piloting with their students, could manage these tasks in virtual modality.

Besides, all teachers who have carried out the training, received a certificate for their participation.

2.3 Teachers Training Results

According to the European Commission, Europe could face a shortage of 900,000 specialized ICT technicians in the nearest future. And according to the study, if there were an equal number of men and women on the digital job market, the EU's annual GDP could grow by 9 billion euros.

The OECD's Program for International Student Assessment (PISA) reveals that the number of boys who imagine themselves as ICT professionals, scientists or engineers is far greater than that of girls.

For example, the study shows that young Italians rank in the top three in Europe in terms of interest in science and IT subjects; in particular, an insignificant share feels reach for mathematics (41.7% compared to the European average of 37.6%) and information technology (49.2% compared to the European average of 42.2%).

Although they are convinced that their generation is the first in which men and women have concretely equal opportunities in all social spheres, the girls are convinced that there are still no equal job opportunities in the STEM field. Besides, the compliance with social expectations, gender stereotypes, gender roles and the lack of reference models are additional factors that guide the professional choices of girls away from STEM fields.

Moreover, the results show that the major difficulties young people are facing with STEM subjects (Figure 7) are mainly connected to how to translate the meaning of STEM subjects to real-world context (45,9%) and the problem-solving process (29,5%). Besides, some teachers answered “other” due to multiplicity of the reasons standing behind these difficulties, which mainly are reducible to the following: problem definition, problem-solving process and to translate the meaning of STEM subjects to real-world meaning.

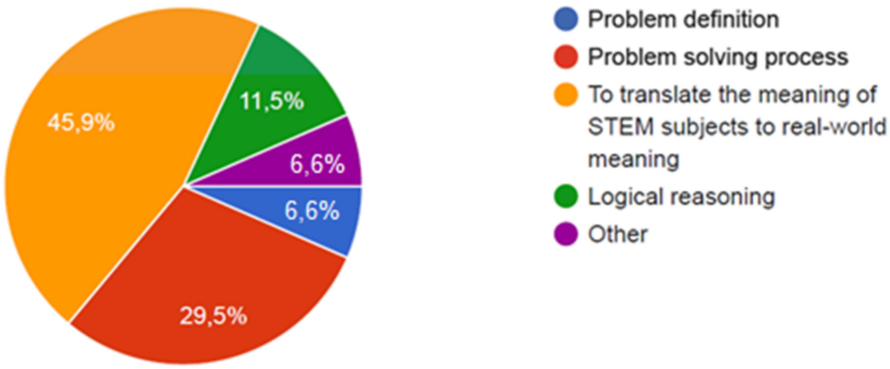


Figure 7 - The difficulties faced generally by young people in STEM subjects.

The difficulties revealed are related to the incapability to see the relation between STEM subjects and reality. This means that young people don’t see their actual applicability, therefore affecting the perception of STEM topics negatively.

In this context, teachers recognize that the main important issue of STEM teaching and learning processes improvement is focused on two key points. On one hand, students’ motivation in STEM subjects study should be increased (47,5%) and, on the other hand, the teaching methods have to be changed and improved (36,1%) to create an innovative learning environment. However, 9,8% of teachers think that teachers’ training should be intensified.

The attitude of teachers towards the “art” element inside STEM subjects study is quite diverse. The expected benefits of learning by using the art-works (Figure 8) can be found in the capability of the art to: stimulate activities by increasing student’s curiosity (32,8%); support students with learning by doing (23%); help them on how to solve more complex problems (21,3%) and provide them with more experience in realistic problems (19,7%). Even though there is a percentage of 1,6% of the teachers who see “art” as something which neglects the STEM core nature.

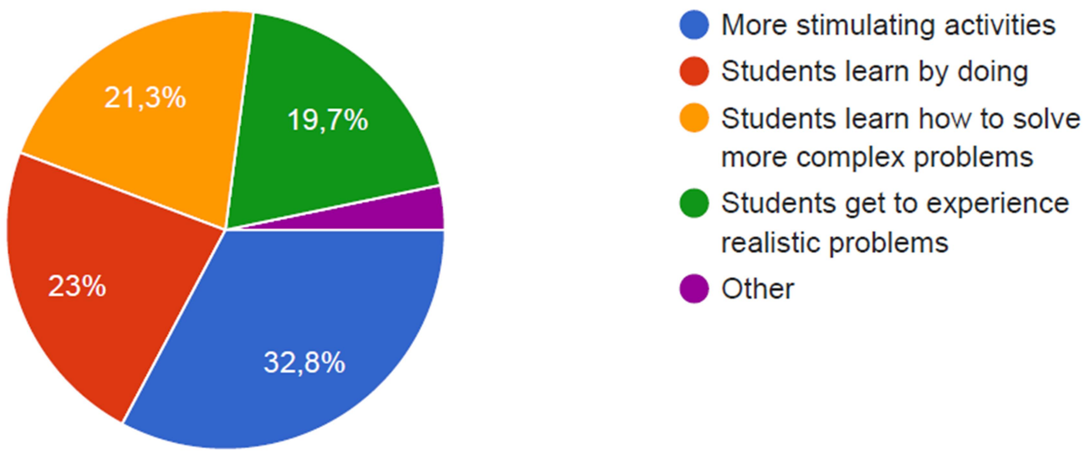


Figure 8 – The expected benefits of learning by using the art-works.

On the contrary, the perceptions of the expected benefits in the learning process by using the mini-game concept design are more evident and identifiable, mainly in the improvement of problem-solving strategies in students (45,9%) and in increased attention and motivation from them (41%). However, this methodology can help students in a wider knowledge of objects, events, phenomena and the identification of the right action strategies by supporting them in design-based research, prototyping and in logical reasoning.

Therefore, teachers, before attending the G.A.STEM training, considered the potential benefits of learning for their students through the project methodology and tools application, above all in the increasing curiosity for STEM subjects by the students (39,3%); in providing a different use of learning strategies (27,9%); in offering a better contextualization of real problems to be studied (23%) and in contributing to present the information in different ways (8,2%).

On the basis of the results achieved, after the G.A.STEM course completion, all teachers involved in the piloting phase (100% of which 24,6% selected “agree” and 75,4% “strongly agree”) are more convinced about the effectiveness that the tools developed could support the achievement of students’ learning objectives in STEM education, because STEM is the future for students.

This is confirmed also by the fact that the attitude of teachers towards “arts” has changed. Indeed, as follows from Figure 9, they underline how the use of art-works can support students’ learning in other subjects across the curriculum by providing them with more stimulating activities (54,1%) and with more experience in problem-solving process (21,3%) by supporting in solving more complex problems (11,5%). Moreover, some of the respondents (13,1%) recognizes in the use of the art-works in the curriculum as the instrument to favour students’ learning by doing and further facilitation of the learning process.

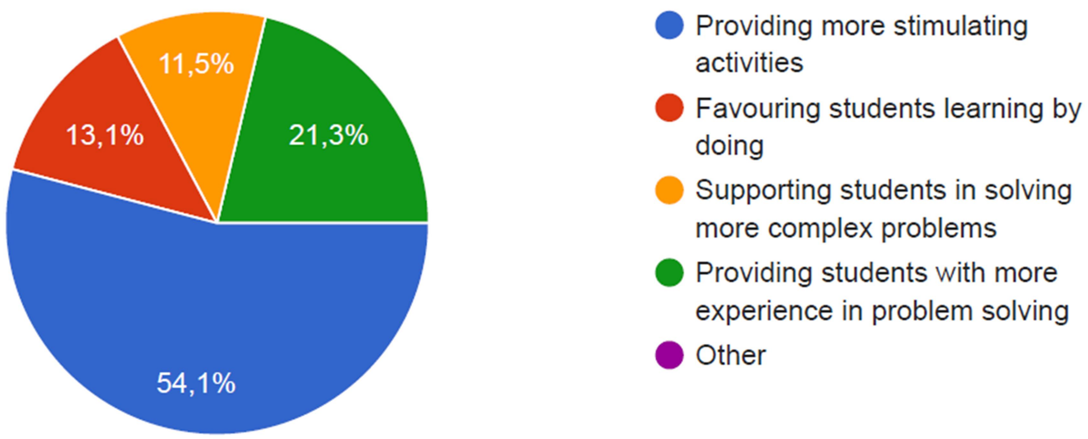


Figure 9 - The ways of how the use of art-works supports students' learning in other subjects across the curriculum.

As regarding the attitude of teachers towards the mini-game concept design, the results demonstrate an essential reinforcement of the idea that their use in supporting students' learning in STEM education may be productive. In fact, the use of the mini-game concept design in STEM subjects can increase, first of all, students' attention span and motivation (63,9%); support them to identify the right action strategies for scientific context (13,1%) and, in the meantime, can offer a wider knowledge of objects, events and phenomena and improve the problem-solving strategies (Figure 10).

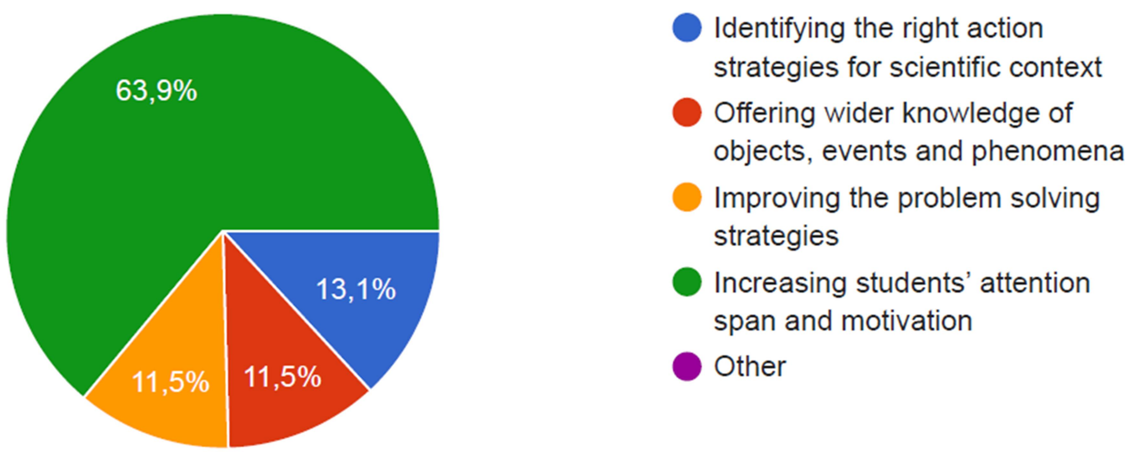


Figure 10 - The ways of how the use of the mini-game concept design supports students' learning in STEM education.

Finally, after the training, teachers were asked to quantify the potential perception of the G.A. STEM methodology by students. Results demonstrate (Figure 11) very positive feedbacks (95,1%) against only 4,9% of respondents who remained neutrally disposed.

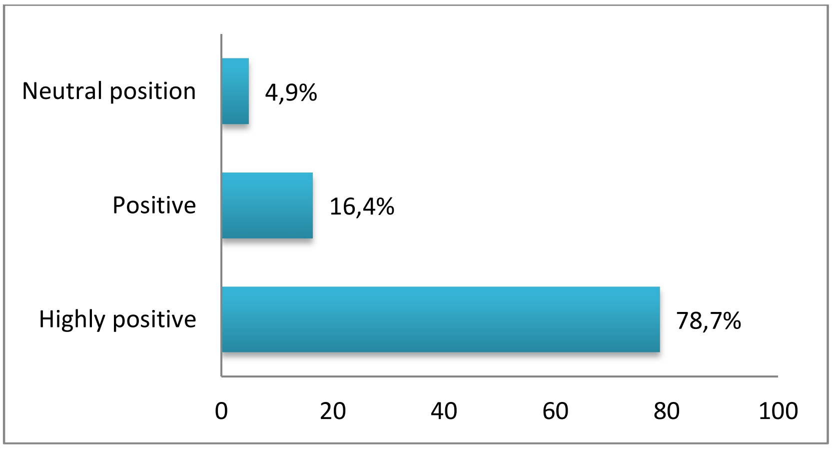


Figure 11 - The potential perception of the proposed methodology by students.

This result is confirmed by the evaluation of the possible degree of fun for the students in the implementation of the proposed method. In this case, the teachers' feedback was more positive with 98,4% against 1,6% who keep a neutral position.

Concerning the evaluation of teachers on the usability of the G.A.STEM methodology and tools, it results to be very positive because it offers different approaches in line with the 21st century key competences development. Moreover, it can be supportive for the classroom and useful as a good challenge for both teachers and students.

However, it requires the right preparation to be effective and it would be better to extend the examples combining arts and mini-games concept design to a wider spectrum of subjects including science or chemistry.

Table 1 – The usability of the G.A. STEM methodology and tools

How do you evaluate the usability of the G.A. STEM methodology and tools?
The usability of G.A.STEM is good but I would have been happier to find more subjects concerning science, the subject that I teach.
Very good
It's great thank you
Excellent with the right preparation
Very important and fun
Very useful
G.A.Stem methodology is easy to use with students.
There are many different tools and the time is needed to become familiar with the implementation. It is a good way for distance learning with students.

3. STEM SKILLS DEVELOPMENT: STUDENTS PROJECT WORK

The target group involved in the second phase of the piloting were 11-16 years-old students. The priority was given to the students of the previously trained teachers. In addition, the priorities for the potential participants were supposed to meet the following requisites prior to participation:

- Have difficulties in learning processes;
- Have low basic competences or background with school failures;
- Risk of school leaving or social exclusion.

The students' selection was carried out directly by the teachers involved due to the pandemic restrictions.

Also, the session addressed to develop the project work with the students was inevitably affected by the COVID-19 situation. In fact, the activities were realized in both face-to-face and online modalities and the timeline was extended up to January 2021 instead of November 2020 to provide both teachers and students with wide flexibility in the realization of the activities.

However, not all the teachers trained could implement the tasks with their students due to the partial/total lock-down. Some of them found difficulties managing the students' project work realization in the online modality. Therefore, the partner countries, which could manage the experimentation with the students, were Finland, Belgium and Italy. Besides, students from Greece were actively involved in the experience by developing their project work.

3.1 Students' Profile Description

The total number of students involved was 153 (of which 62,7% male, 33,3% female and 4% not-specified) from Finland, Belgium, Italy and Greece (Figure 12).

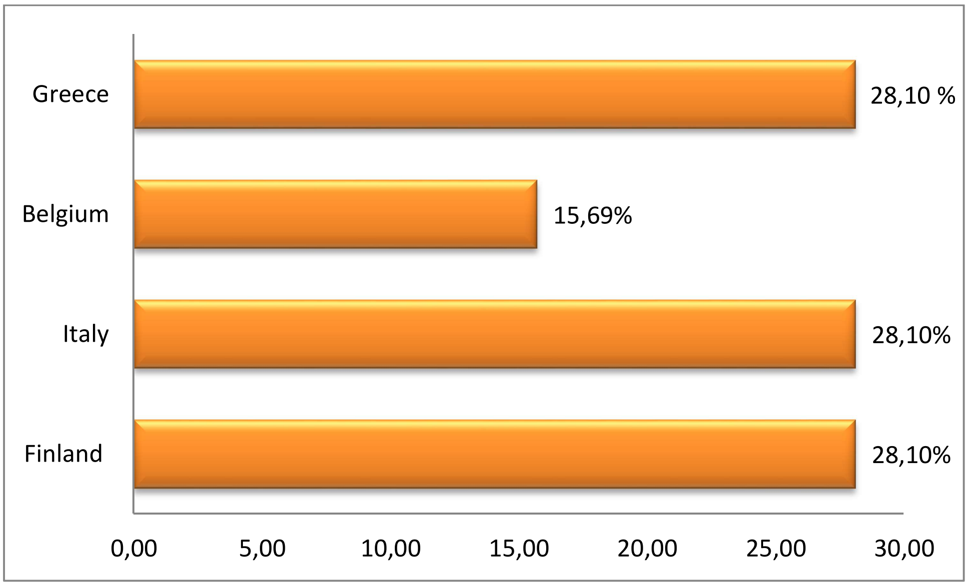


Figure 12 - The countries involved in the piloting phase with students.

The age of students ranged from 11 to 16 years-old, in particular, the target group included 14% of students between 11-12 years old; 31% between 13-14 years old and 55% between 15-16 years old.

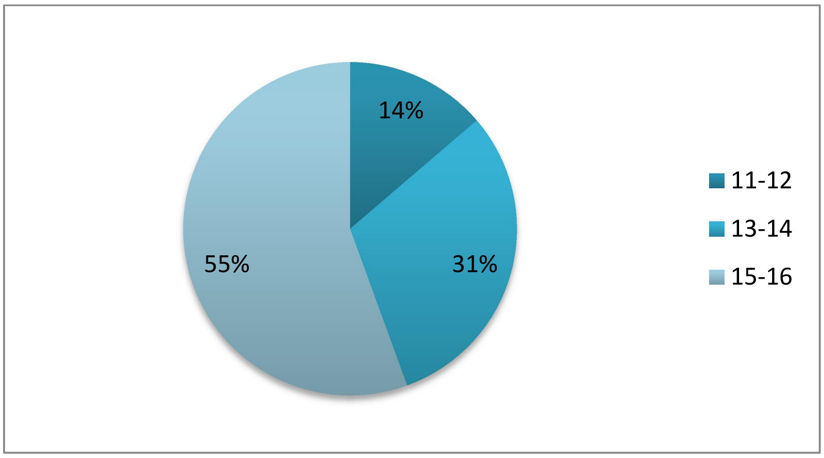


Figure 13 - Students age.

To have an initial overview of the students' profile, the preliminary questionnaire aimed to describe three different attitudes before starting the project work realization, namely: the first was to measure the grade of comfortability towards both mathematics and science; the second was concerning the relation between mathematics/science and arts and, finally, the third was towards the mini-game concept design.

The initial attitude of students involved in the scientific disciplines is rather positive. Most of them don't think they are boring, notwithstanding a small group of them has assumed a neutral and negative position (36% against 64,1% with a positive feeling). They use scientific topics not only at school or to do homework.

The fact to use scientific topics outside the school doesn't change the attitude of students towards both mathematics and science. In fact, both subjects are considered too abstract, too far from reality. Actually, 21,5% of students "strongly agree" and "agree" that mathematics is too abstract and the 24,2 considered science too abstract, even if both the disciplines are evaluated as important and relevant after the school years. Besides, the high percentage of students remain in a "neutral position" - 35,9% towards mathematics and 28,1% science correspondingly. This is because the connections between mathematics and reality don't appear so evident during the learning process and often teachers offer to students an over-theoretical approach causing the perception that mathematics is abstract and far away from everyday life.

Despite this, 66% of students involved like to attend mathematics and science class against an 18,3% of respondents, who remained in a neutral position and 15,6% of those with a negative attitude towards the subjects.

The data show that most of the students (42,5%) never thought that mathematics and science can be included in this unusual aspect, "arts". Besides, a quite high percentage of students (28,1%) held a neutral position by underlining the difficulty to be able to see and comprehend the relation between mathematics/science and arts. This is also confirmed by a high percentage (30,1%) of the students with a neutral position towards the use of the arts in the mathematics and science study to increase the interest in these subjects.

However, 53,6% of students think that the use of the arts could increase their interest in the study of these subjects as shown in the following figure.

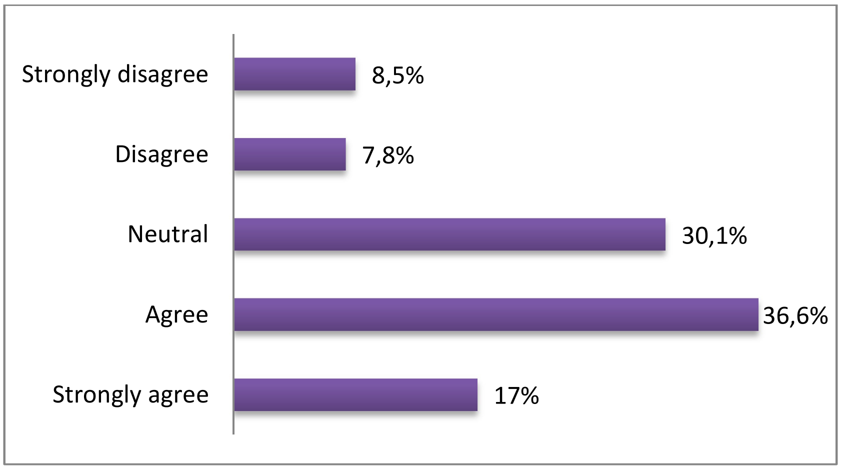


Figure 14 - The initial attitude towards the use of the arts as a means to increase students' interest in both mathematics and arts.

The fun has a positive effect on motivation levels, determining what we learn and how much we retain. Learning isn't a one-off event. It requires repetition and dedication. If the experience is fun, learners will stay curious and keep coming back for more and have more meaningful opportunities to apply what they studied. When teachers use activities that make learning engaging and fun, students are more willing to participate and tackle the challenges. Having fun while learning also helps students retain information better because the process is enjoyable and memorable.

The potentiality of the fun as a motivational tool in the learning process of the students (82,4%) is also recognized by the students themselves.

Another aspect analysed was the initial attitude of the students towards the game concept development. Most of them (68,6% against 31,4%) knows what is the game concept and among them, the results collected show that 48,9% have already developed and designed it while 18,5% never tried and 32,6% would like to do it (Figure 15).

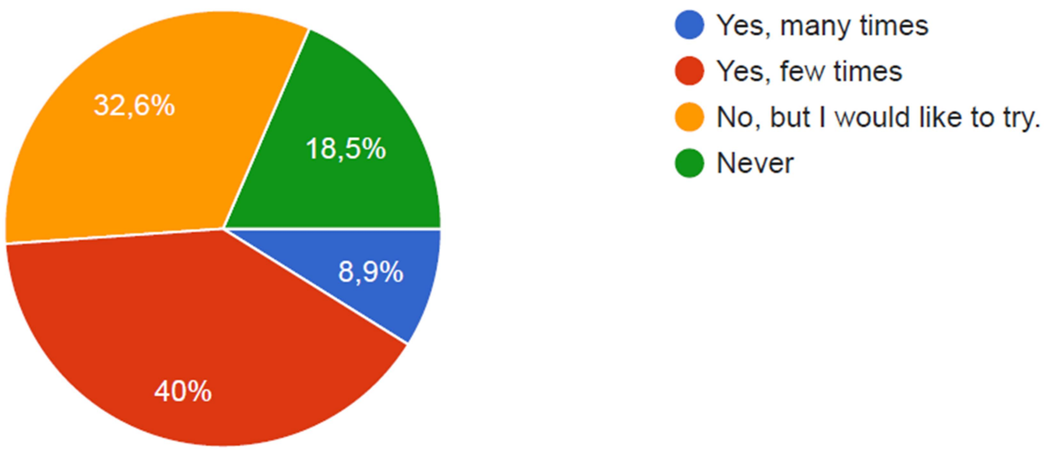


Figure 15 – Frequency of the game concept design/development by the students involved

3.2 Students activity implementation

Students' project work was implemented according to two steps: the first step aimed to define the combination between art-works and scientific topics and the second one to design and develop a game concept on the base of the combination found. At the end of their activities, students were expected to draw up their project work following the template prepared by the project team to support them in the game idea development (ANNEX 6 - Mini-game Concept Design Template).

Teachers had two suggestions on how to organize the piloting phase with their students in order to have maximum flexibility and mainly to adapt the activities to be carried out due to the pandemic restrictions.

The first suggestion was that teachers could use the learning materials already selected and studied during their training phase. In this case, students were expected to modify and transform the examples of the mini-game concept design already prepared by the G.A.STEM team. The second one was that teachers could use the art-works already selected only as examples to be shown to their students and, afterwards, they could choose their works and identify the interconnections between art-works and scientific subjects trying to make a mini-game design and assets.

In both cases, teachers could have at their disposal all the mini-game concepts' design examples prepared by the project team through the webpage https://sites.google.com/view/gastem-mini-game (Figure 16).

Figure 16 – Google webpage showing all mini-game concept examples designed.

The students could work in a group with other peers or individually. However, most of them (64,1%) preferred to realize the project work in small-groups against 35,9% of participants who preferred to work individually. The last has increased the motivation in the activities' finalization because it provided them with the opportunity to share and to come up with creative ideas on the game concept development and, at the same time, to facilitate the tasks.

When all the project works were ready, some teachers uploaded them in the G.A.STEM platform in the section “Students Project Work” (Figure 17).

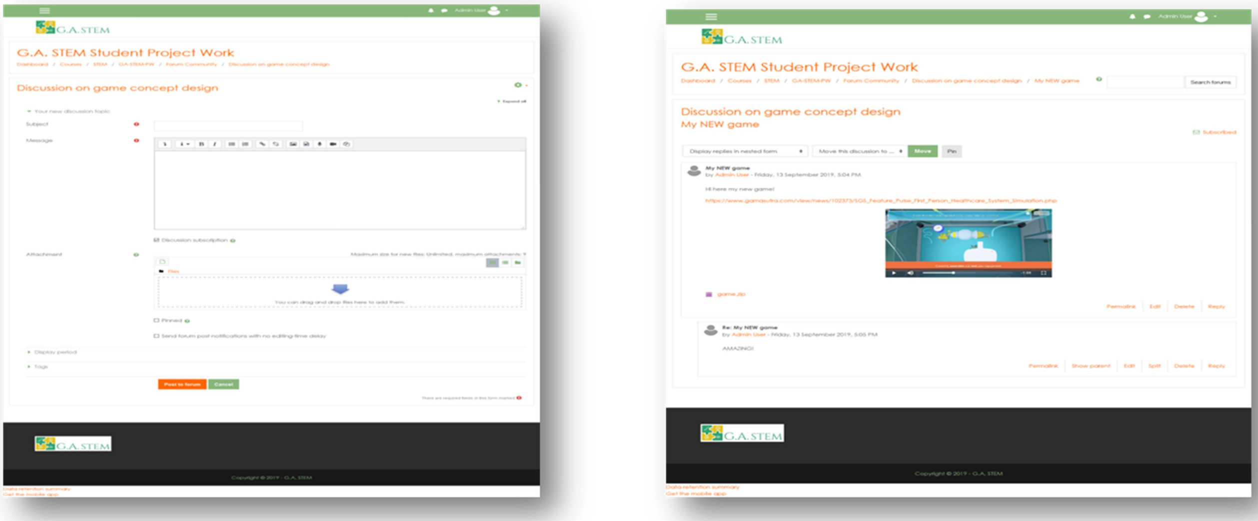


Figure 17 - G.A.STEM platform - Students’ Project Works section.

Besides, all students who have submitted their project work received a certificate for their participation.

3.3 Students’ results

After the project work realization, students involved were asked to compile the follow-up questionnaire to collect data about any changes in their attitude regarding the combination of the scientific disciplines and arts and to evaluate their experience in mini-game concept design.

The use of the arts in the mathematics and science study helped students to perceive and better understand the real applications of the concepts studied as shown in the following figure.

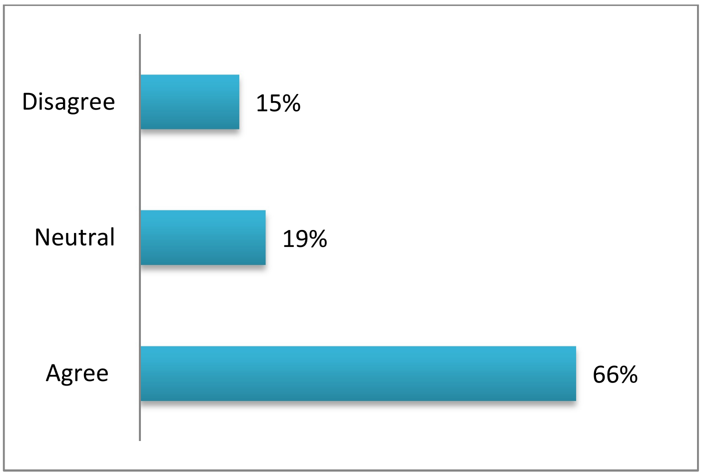


Figure 18 - A better understanding of the real application of mathematics and science concepts by using the art.

Comparing the results achieved before and after the students' project work organization, data have revealed a substantial improvement (+43,15%) of the understanding of the real application of the mathematics and science concepts studied by using the arts. Actually, even the neutral positions have also fallen dramatically (-13%) in favour of a greater understanding of the scientific concepts explained through the works of art. This has been confirmed by 64% of students who stated that the contents learned seem more concrete and practical than before.

All the students have recognized the value to be original and to show their creativity through the development of the mini-game concept idea (Figure 19).

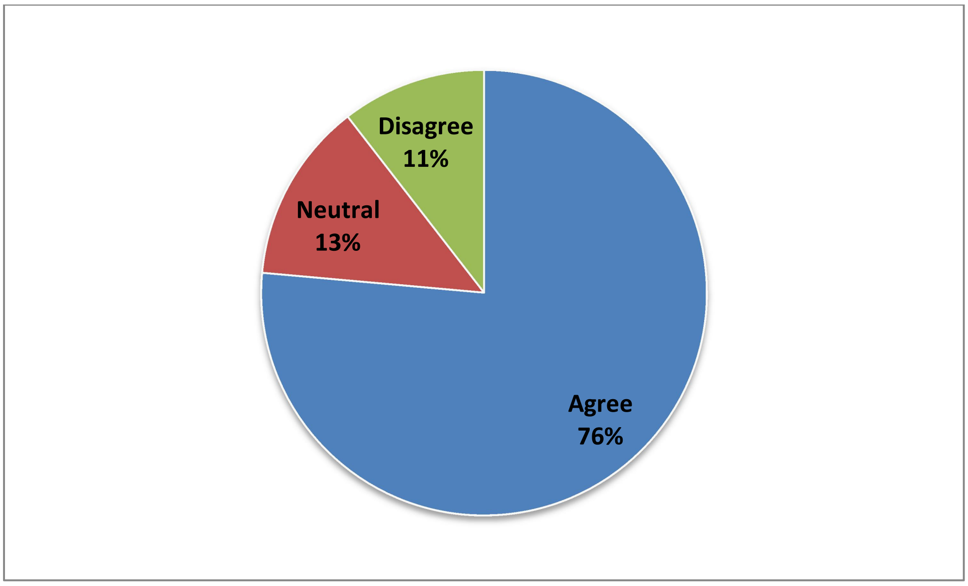


Figure 19 - Results referred to the inquiry: "I can use my creativity and to be original in the mini-game concept idea development".

However, some of them, in particular, 11% have had some difficulties in the development of their mini-game concept idea while 13% of students still remained in a neutral position. Despite this, the students feel comfortable using the G.A.STEM method and tools (77,4% against 15,7%). The difficulties emerged during this phase were mainly due to the combination of the project work finalization with the pandemic restrictions, in particular, when the students were obliged to do it in online mode when their schools were closed for lock-down or semi lock-down.

The following figure shows that the students revealed an increased motivation and interest (63%) in the mathematics and science study by using the art-works as learning tools. Comparing these data with the initial ones (ref. Figure 14), the results demonstrate an increase of 12,6% in both interest and motivation in the current study with a decreasing of -9,7% in the neutral position.

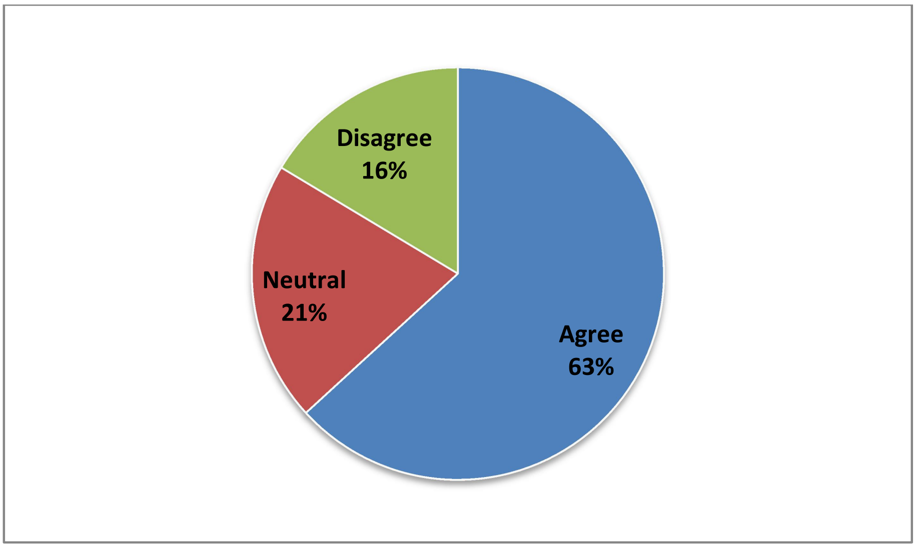


Figure 20 – An increased interest in the mathematics and science study by using "art-works".

Also on the base of the involvement of students in the development of the mini-game idea, the collected data show an increase in the students' interest in mathematics and science (65,4%) which has grown to +14,8% with respect to the initial data achieved with corresponding decrease in the neutral position (-10,5%). Therefore, both the tools (art-works and mini-games development idea) positively affect the learning process, mainly, the interest and motivation of the students in the mathematics and science study. To be more precise, the use of the mini-games concept design impacts more positively (+2,2%). From one hand, among the underlying reasons is the fact that the combination between the scientific subjects and the artworks often is not so evident and immediate. Besides, the survey reveals that the creation of the mini-game concept using the mathematics and science concepts studied was easier than finding the art-works related to them.

On the other hand, creating a mini-game was more interesting and funny (81,7% against 7,9% negative and 10,5% in neutral position). This was confirmed by the desire to know more about the mini-game design (69,9%).

5. GOOD PRACTICES AMONG STUDENTS PROJECT WORKS

5.1 Country: Belgium

Schools	Sint-Lievenscollege
Country	Belgium
Selected exercise description	The game has to be played in groups. The setting is a piece of Belgian architecture, the Atomium in Brussels. The players will have to practice their transformations for which they'll earn points. With these points, they will be able to unlock crates and other objects. The players can give their points and objects to each other so that the group will become stronger and not only the smartest individual. When the players deem themselves strong enough they can attempt to defeat the monster who occupies the Atomium. The idea is to apply transformations in the plane on this piece of architecture. You will have to resolve problems of transformations in the plane, in solid geometry as an extra on what we see in plane geometry. The different transformations we saw are reflection, rotation, translation, reflection on a point and symmetry. When mastered there is a possibility for harder levels. It is in essence a multiplayer, thinking and action game.
Selected art-work description	Atomium Brussels Belgium Architect: André Waterkeyn and Jean Polak Built for the World Expo in 1958 (Expo 58) in Brussels. It suggests one atomic iron cell, which was an important element in that time. It played a big role in the optimistic view of the fifties in Belgium. It consists of nine spheres, each with a diameter of 18 meters. It is the crystallized cubic centred structure of iron, only 165 billion times bigger.
Students Project Work	https://3dwarehouse.sketchup.com/model/68a2be51efafd7a5b3132afb1c62c517/Atomium?hl=nl This link is a 3D model of the Atomium. Each sphere should get a letter so all transformations can be done. The model can also be expanded to a more difficult level. (4 models can be combined) The different transformations will be reflection, translation and reflection on a point.
Project work implementation	It was difficult to link math and art. At first, we didn't know how to start. After a few examples from their teacher, the students knew what to do. They worked in groups of four people. They started with a brainstorming session. Which subjects of mathematics do they like, to what art can they link that. They used the most original idea to make our game. It was fun to do, they learned a lot and, above all, they were able to experience that mathematics can be found in many facets.
Strengths points:	- It was great to link mathematics and art. - It was super cool to discover that math is much more than the theory students get in the lessons. Now they saw everything applied in art. Nice discovery. - Board games are easy to make in class, simple games using scratch software are also doable in class.

Weak points:	In the end, students were not able to make the game themselves. Students had too little time and maybe they don't know enough how to get started in game making. For actual game making, on the computer, they would need better computers, specific software and more instruction from someone specialised in game making online.

Schools	Sint-Lievenscollege
Country	Belgium
Selected exercise description	The man with the flag has been murdered!!!!! You have to find out who the murderer is, by completing assignments about the painting (Madonna met kanunnik Joris van der Paele) and mathematics (developments, surfaces,...). This game is more interactive and guided. You find the murderer by completing given tasks in a subsequent order. When you answer correctly, you earn 10 points, if incorrect, you'll have to answer again until correct, but you will not earn any points. By moving on, you'll first discover the weapon used in the murder, then you'll find out where the residue was found and so on. You'll actually move through it like a real murder investigation. It's a bit cluedo meets math meets subway runner. Because after you find the culprit, you will have to chase him by overcoming obstacles. Whilst running you'll pass checkpoints where you'll have to exercise. These exercises can give you bonus strength or speed when answered correctly. If wrong, however, you will slow down. You can also collect coins whilst running. With these coins, you can upgrade your figurine into a more powerful one. You keep running and solving problems until the culprit is caught.
Selected art-work description	Madonna met kanunnik Joris van der Paele. Painting from Jan van Eyck, besides the Ghent Altarpiece, his biggest oil painting that we still have to this day. This painting is probably one of the first paintings that is an example of the Sacra Conversazione. A painting where saints and even commoners are painted realistically like they're having a normal conversation. The painting is 141 cm on 176,5 cm big. This painting was ordered by this Joris van der Paele in 1434 but was only finished in 1436. This piece could have been an altarpiece or an epitaph.
Students Project Work	https://docs.google.com/presentation/d/1yMd_6bhFWZgQhpamd8qT_uKt4meVMDu0/edit#slide=id.p2
Project work implementation	It was difficult to link math and art. At first, we didn't know how to start. After a few examples from their teacher, the students knew what to do. They worked in groups of four people. They started with a brainstorming session. Which subjects of mathematics do they like, to what art can they link that. They used the most original idea to make our game. It was fun to do, they learned a lot and, above all, they were able to experience that mathematics can be found in many facets.

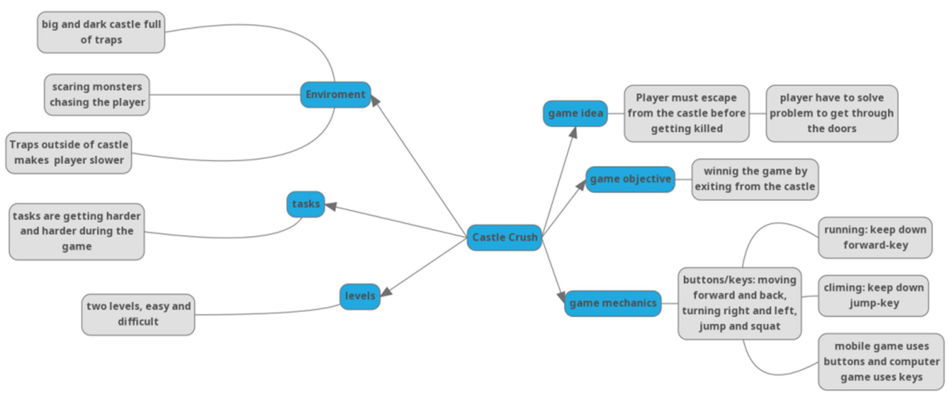
Strengths points:	- It was great to link mathematics and art. - It was super cool to discover that math is much more than the theory students get in the lessons. Now they saw everything applied in art. Nice discovery. - Board games are easy to make in class, simple games using scratch software are also doable in class.
Weak points:	In the end, students were not able to make the game themselves. Students had too little time and maybe they didn't know enough to get started in game making. For actual game making, on the computer, they would need better computers, specific software and more instruction from someone specialised in game making online.

5.2 Country: Finland

School	Rieskalahteen Koulu
Country	Finland
Selected exercise description	Big game: The Game is a survival evolution game. Sudents planned a game with the idea to evolve from an animal to another animal by eating other animals. Tasks are combining art with biology. Big game: The Game is game concept made during one week by three 15-year-old students.
Selected art-work description	Students picked up several animal characters as art-work. Players have to choose from two paths of six evolving animals.
Students Project Work	• The games idea is to evolve from an animal to another animal by eating other animals • For example. If I am a mink i need to eat food until I get 100 experience points. • When I have eaten enough food for level up, I evolve to raccoon dog. When I'm a raccoon dog I have to eat minks, other raccoon dogs, and food for the next level up. • There are two evolve paths at the start of the Big game: The game • Rabbit -> Beaver -> Roe deer -> Deer -> Wild boar -> Moose • Mink -> Raccoon dog -> Fox -> Lynx -> Wolf -> BEAR. The challenge is to get to the top of the food chain and get as much points as possible. • The genre is survival evolution. • Made to 7-15 year olds. • Computer/ Mobile game. • The map is a forest. • The game teaches the cycle of life.
Project work implementation	Students were excited about their own game idea. It was difficult to start. They worked individually and in small groups.

Strengths points:	A lot of good game ideas came from students and they managed to reach agreement of what kind of game they want to do. Couple of weeks later many students asked if we could start another game planning session. There are several students that are more active and receiving, when we are using workshops like planning games.
Weak points:	Students didn’t have enough time to finish their game. Several big challenges arised during the session. Students were in trouble choosing the level of their game. Should they plan simple game they could finish properly or plan a very interesting game only with good idea. Most of them spent the whole time planning the great idea. Combining the game, arts and stem was difficult.

<table>
<tr><td>School</td><td>Rieskalahteen Koulu</td></tr>
<tr><td>Country</td><td>Finland</td></tr>
<tr><td>Selected exercise description</td><td>Castle crush is an adventure in the castle. Students planned a game where player have to solve some tasks in order to survive and escape from castle. Tasks were combining art with mathematics.
Castle Crash is game concept made during one week by three 13-year-old students.</td></tr>
<tr><td>Selected art-work description</td><td>Students picked up several art-works and included them into tasks. Player has to solve mathematical problems which are linked with art-works.
They worked individually and in small groups.</td></tr>
<tr><td>Students Project Work</td><td>The students’ project work is showed in the following conceptual map:



</td></tr>
<tr><td>Project work implementation</td><td>Students were excited about their game and they would have finished their work if we have had enough time to spend with game implementation.</td></tr>
<tr><td>Strengths points:</td><td>A lot of good game ideas came from students and they managed to reach agreement of what kind of game they want to do. Game idea was ready to implement and students were able to do actual game with Scratch.</td></tr>
</table>

Weak points:	Students didn't have enough time to finish their game. Two big challenges arised in their game idea. How to find mathematical problems which combines art and how to get proper difficulty level. Their game idea was good but we did not have enough time to implementation because of very exceptional school year due to covid19.

5.3 Country: Italy

Schools	IIS "Marconi-Guarasci" of Rogliano (Cs) Class II C Liceo Scientifico Scienze Applicate
Country	Italy
Selected exercise description	Creation of an interdisciplinary learning unit on gambling in line with the objectives of the PTOF relating to the acquisition of digital skills and citizenship.
Selected art-work description	The art-works observed and studied were found on the Internet by students during research on gambling. In particular, they dwelt on "Caravaggio's cheaters", "Paul Cèzanne's card players" and Nefertari playing senet. The materials produced by the students were included in the following file: https://drive.google.com/file/d/1dQsK2fhw42tx5NYtKam8aGqnKuySHisC/view
Students Project Work	A video game has been implemented with Scratch "the game of 11" in which the performer always wins, proving that not all games are fair and the activity was reported for Codeweek 2020 HTTP: // www .codeweek.it / codeweek-2020 /. 1. https://scratch.mit.edu/projects/432267844 2. https://scratch.mit.edu/projects/433767326 Video description: https://www.youtube.com/watch?app=desktop&feature=youtu.be&v=m6bXNbpQ4wQ
Project work implementation	The activity was carried out in parallel in two classes (I and II C of the high school of applied sciences) as a welcome activity at the beginning of the school year 2020/2021. Both classes worked in groups of 3-4 members both in presence and remotely and appeared motivated and interested in the multidisciplinary approach.
Strengths points:	- The possibility of studying a non-scholastic topic, developing it from various points of view and exploring paths and connections between disciplines. - The creation of the mini-game was a useful moment to develop problem-solving skills and to discover some solution strategies. - The exchanging between peers and with the teacher, the workshop approach and the freedom of action were particularly appreciated by the students. - At all stages, they were able to develop their skills to work in a team

	by improving social and English language skills.
Weak points:	Due to the pandemic, during the activity, the students were unable to work in the computer lab in compliance with the anti-covid school regulations. The classes used the IWB, created the groups and discussed. The group work was done at home with their devices and in shared mode.

Schools	Liceo Scientifico Galileo Galilei - Perugia
Country	Italy
Selected exercise description	The contents in this game are all curricular, belonging to the first two years of scientific high school age of students between 14-16 years. **Art**: The Pantheon, its history, architectural description, plan, ancient Rome art imperial, its interpretation. **Latin:** Plinio the Elder - some excerpts from Historia Naturalis **Sciences:** Classical Astronomy, the Celestial Sphere and its fundamental elements (celestial equator, celestial meridian, coluro, zenith, nadir, first vertical, ecliptic, gamma point and omega), Ptolemaic theory, apparent motion of the sun; the motions of the Earth, Rotation and Revolution, trials and consequences; latitude, longitude. **Modern Astronomy**: the Universe and the theories on its origin, 380,000 years after the big bang, the transition from opaque to transparent Universe, the birth of stars, galaxies, the radiation of the bottom. **Physics**: Elementary Particles **Chemistry**: the Atom, the first 28 elements of the periodic table, the main characteristics, the solid-state of matter. **Geology**: the silicates, chemical classification of minerals; the classification of the rock in magmatic, sedimentary and metamorphic; training environments. **Plane geometry:** the regular plane figures, rectangle, square, circle, triangle. **Mathematics:** proportions, area calculation, Fibonacci series, the golden section. **Coding**: Building a game using Scratch.
Selected art-work description	The Pantheon located in Rome, today is a Catholic church, the Basilica of Santa Maria *ad Martyres*, but its origin dates back to the period of ancient Rome, it was exactly a temple wanted by Marco Agrippa, during the reign of Augustus (27 BC - 14 AD). Following a fire, Emperor Hadrian had it rebuilt, modifying the original structure, but he chose to keep the ancient inscription of Agrippa. The building is cylindrical with a portico of large Corinthian columns in granite (A rectangular vestibule connects the portico to the rotunda, which is located under a coffered concrete dome, with a central opening (oculus) towards the sky. of the eye and the diameter of the inner circle are the same, 43 meters (142 feet), that is 12 times the side of the larger square in the floor. The large circular domed cell of the Pantheon represents the celestial sphere, the cornice corresponds to the celestial equator, the light, that filters from the niche, draws the architectural elements of the temple, in particular, the floor 8 large, small and circle squares, which become the element and constructive key of the whole

	temple and of the game to be created. The minerals and rocks that form the floor, the positions of the light that crosses the oculus at different times of the year and that describe the architectural elements of the temple, the Ptolemaic model of the Universe, the apparent motion of the Sun.
Students Project Work	The story of the game. A boy meets the custodian of the Pantheon who begins to tell him the history of the building, the boy will find himself having to build the floor of the Pantheon by inserting large and small squares and the circle each time. Each time he will have to answer questions, divided by topic and degree of difficulty. The aim is to reach the third level and then arrive at the centre of the floor which will allow a journey through time; the protagonist will be in another monument of another era, but with the same constructive intentions, this will make the game open for the following years.
Project work implementation	The students were divided into 14 groups of two students each. Each group had very specific tasks of research, validation and construction of a product connected both to the game and to the study of curricular topics. It was created a game, its story, the purpose and the rules by using Scratch.
Strengths points:	Involvement and motivation to learn, have fun learning and build a final product.
Weak points:	Time for the product realization must be well defined and shared with colleagues in the class, this has not always been possible, furthermore, COVID-19 has made everything more difficult, in fact, a lot of work has been done in lockdown.

5.4 Country: Greece

School	Evangelika Model High School of Smyrna http://lyk-evsch-n-smyrn.att.sch.gr/wordpress/?p=1322
Country	Greece
Selected exercise description	The students were asked to write and solve geometrical problems based on the objects of material culture that they had chosen. In particular, they tried to formulate and solve geometric problems on the objects of art, based on the theorems and propositions of the properties of the quadrilaterals.
Selected art-work description	Cultural heritage is a basic component of each country, as it includes all values from past to future. In other words, is treasure through the years. Science, Technology, Engineering and Mathematics (STEM) included in many subjects in curriculum STEM teachers could use Europeana collections for educational purposes in the STEM classroom. Mostly it analyses the case study of teaching and learning geometrical concepts based on objects of collections of the digital cultural heritage of Europeana (https://www.europeana.eu/en/collections). https://drive.google.com/drive/folders/1V1d5O2JSCUxX1GlAPVAGhTmS3i

	_RSTY3
Students Project Work	https://scratch.mit.edu/projects/465591328 https://scratch.mit.edu/projects/466538448 https://scratch.mit.edu/projects/467237974
Project work implementation	1st phase-preparation: Students were asked to explore the collection of the digital cultural heritage of the Europeana project (in the Greek version). During the online meeting (duration 2 hours) presented the alternative ways of using the digital collection offered by the Europeana project through particular examples. The students were asked to write and solve geometrical problems based on the objects of material culture that they had chosen. The problems above have been selected as characteristic examples of the qualitative analysis of students' projects in which students. Investigate, analyse and justify the properties of the quadrilaterals through the critical review of visual representations/art objects. Utilize the experience and pre-existing knowledge for the formulation and solution of geometric problems on the objects of art, based on the theorems and propositions of the properties of the quadrilaterals.
Strengths points:	Cultivating a spirit of inquiry, promoting inclinations, strengthening interests, learning ways to organize strategies and methods to solve problematic situations, the ability to select and compose material, develop collaboration and engage in a constructive and fruitful dialogue between students are among the curriculum educational goals for all students, regardless of their performance.
Weak points:	Schools closed and distance learning did not support innovative approaches and methodologies.

5. RECOMMENDATIONS AND FUTURE IMPROVEMENT

On the basis of the qualitative and quantitative data achieved and the examples of the project works realized by the students involved, the G.A.STEM methodology and tools show its innovation and effectiveness. Their usability is recognized by the teachers engaged in the experience. However, the proposed methodology should be extended and adapted further involving the concepts of other scientific disciplines (e.g. biology, chemistry, etc.).

Besides, the replicability of the experience implies providing teachers with a good preparation to manage and to use both G.A.STEM methodology and tools. This is a very important element, because finding the connection between scientific subjects and art is not so easy, mainly for young students. The students, who possess these difficulties, could finalize their task thanks to the support received from the teachers and being oriented through the practical examples developed by the project team.

From the comparison of the data achieved before and after the students' project work organization, the results show a substantial improvement (+43,15%) of the understanding of the real application of the mathematics and science concepts studied by using the arts. This has affected also the students who assumed a neutral position before starting the activities, shifting them to positive feedback contributors.

The motivation and interest in the mathematics and science study by using the art-works as learning tools were augmented. Actually, the results demonstrate an increase of 12,6% in both interest and motivation in the current studies with a decreasing of -9,7% in the neutral position.

Both the use of the art and the mini-game concept design affect positively the learning process, mainly, the interest and motivation of the students in the mathematics and science study, notwithstanding a negligible difference (+2,2%) between the use of the mini-games concept design and the use of the "art-works".

According to the teachers' feedback and observations, the G.A.STEM methodology and tools support also both vertical and horizontal skills useful for social inclusion and future professional careers. In particular, students have worked in groups and individually by favouring social and communication skills. Besides, students, through participating in brainstorming sessions on their game concept formulation combining scientific subjects and arts, have developed problem-solving skills and their creativity as stated by a teacher: "*Cultivating a spirit of inquiry, promoting inclinations, strengthening interests, learning ways to organize strategies and methods to solve problematic situations, the ability to select and compose material, develop collaboration and engage in a constructive and fruitful dialogue between students are among the curriculum educational goals for all students, regardless of their performance*".

Concerning the professional skills, they could improve their digital skills while trying to realize their game's idea by using, mainly, Scratch for coding.

The experience has been recognized as an opportunity to know more about their own cultural heritage, for example using a platform like Europeana.

Unfortunately, due to the pandemic restrictions, the students couldn’t exploit all the potentialities and the opportunities offered by the method. In fact, the impossibility to use the informatics laboratories or to share their experience face-to-face has influenced all the phases of the project work production. This has caused problems for both the management of the online finalization of their project work and the time needed for the product realization, which should be well defined and shared with colleagues.

One of the major limits, underlined by the method application, was that not all the teachers are predisposed to work in a multidisciplinary and interdisciplinary way. Where it was possible, the students and the teachers could organize the activities better despite COVID-19 situation restrictions obliging students to work online in most of the cases.

In this context, several initiatives have been taken to improve the spreading and improvement of the G.A. STEM methodology and tools.

First of all, new examples combining art and science will be uploaded into the G.A.STEM platform. Secondly, the teacher training “Art and Mini-Games” will be still available in the G.A.STEM platform to provide new teachers with the training. Thirdly, it will remain open on the School Education Gateway platform. Despite the pandemic restrictions, this will allow reaching both teachers already registered, who had problems to manage the students’ project work realization in online modality, and newcomers (Figure 21).

Figure 21 – G.A.STEM training published on School Education Gateway platform.

Finally, G.A.STEM activities will be integrated with other technologies. For example, in Italy, in the Institute Liceo Scientifico Galileo Galilei – Perugia, the engagement level of the students in the G.A.STEM methodology, coerced them to create also a board game by using CoSpace aiming to build 3D tools through the use of block-based coding or advanced scripting by allowing the exploration of their creations in Virtual Reality or Augmented Reality during the next school year. This will enforce the innovation process in teaching methods where students are at the centre of their learning process, in a holistic view, by combining research, sources verification and problem-based learning.

REFERENCES

Anichini, G., et al. (2002). "Matematica 2001. Materiali per un nuovo curricolo di matematica con suggerimenti per attività e prove di verifica (scuola elementare e media)."

Arnab, S., et al. (2012). "Framing the adoption of serious games in formal education." Electronic Journal of e-Learning 10(2): 159-171.

Chehlarova, T. and E. Sendova (2011). "Enhancing the inquiry-based learning via reformulating classical problems and dynamic software." Науковий часопис Національного педагогічного університету імені МП Драгоманова. Серія 3: Фізика і математика у вищій і середній школі(8): 125-132.

Chehlarova, T., et al. (2012). "Dynamic tessellations in support of the inquiry-based learning of mathematics and arts." Theory, Practice and Impact-Proceedings of Cosntructionism: 21-25.

Dochshanov A. M. (2018) Multidisciplinary Roadmap for STEM education: a case study. Conference: 12th Annual International Technology, Education and Development Conference, pages: 2278-2282 - INT

Djaouti, D., et al. (2011). Origins of serious games. Serious games and edutainment applications, Springer: 25-43.

Dochshanov, A. (2017). “Tinkering” as Learning reinforcement towards multidisciplinarity in research-oriented education. 9th International Conference on Education and New Learning Technologies. Barcelona, Spain, IATED: pp. 9855-9859.

Field, M. (2000). "Mathematics through art–art through mathematics." Proc. MOSAIC: 137-146.

Gardner, H. (2005). Educazione e sviluppo della mente. Intelligenze multiple e apprendimento, Edizioni Erickson.

Jiménez Iglesias, et al. (2018). Gender and innovation in STE(A)M education. Bruxelles, European Schoolnet (EUN).

Jonassen, D. H., et al. (2008). Meaningful learning with technology, Pearson Upper Saddle River, NJ.

Tramonti, M., Mathematics Education Reinforced through Innovative Learning Processes. Proceedings of the 9th International Conference on Education and New Learning Technologies, Barcelona, Spain, 2017.

Tramonti, M., Reinforcing Learning Setting through the Use of Digital Tools. Digital Presentation and Preservation of Cultural and Scientific Heritage. DiPP2017 Conference Proceedings, 7, 2017.

Tramonti, M., Technology and Art to Improve Mathematics Learning. Proceedings of the 12th annual International Technology, Education and Development Conference (IATED2018), Valencia, Spain, 2018.

Tramonti, M., Art and Science: Combining Learning Tool. Digital Presentation and Preservation of Cultural and Scientific Heritage, DiPP2019 Conference Proceedings, 9, 2019, ISSN:1314-4006, 145-152.

Tramonti, M., Mathematics and Science Study through the Arts. Proceedings of the 12th annual International Conference of Education, Research and Innovation (ICERI2019), Seville, Spain, 2019.

ANNEX 1 - Pre-piloting Online Questionnaire for Teachers

1. **Country** *

2. **Subjects taught** *

3. **In your opinion, what are the difficulties that young people generally face in STEM subjects?** *

   - Problem definition
   - Problem-solving process
   - To translate the meaning of STEM subjects to real-world meaning
   - Logical reasoning
   - Other

4. **If your previous answer was "other", please, specify here below:**

5. **In your opinion, what is important to improve STEM teaching/learning?** *

   - Increasing students' motivation
   - Changing of teaching methods
   - Modifying the evaluation modalities
   - Intensifying teacher training
   - Other

6. **If your previous answer was "other", please, specify here below:**

7. **In your opinion, what are the expected benefits of learning by using artworks? ***

- More stimulating activities
- Students learn by doing
- Students learn how to solve more complex problems
- Students get to experience realistic problems
- Other

8. **If your previous answer was "other", please, specify here below:**

9. **In your opinion, what are the expected benefits of learning by using the mini-game concept design? ***

- Identification of the right action strategies
- Wider knowledge on objects, events and phenomena
- Improvement of problem-solving strategies
- Increased attention and motivation from students
- Other

10. **If your previous answer was "other", please, specify here below:**

11. **In your opinion, what are the expected benefits of learning by using the G.A. STEM methodology and tools application? ***

- Different ways of presenting information
- Better contextualizing of real problems
- Different use of learning strategies
- An increased curiosity for STEM subjects by the students
- Other

12. **If your previous answer was "other", please, specify here below:**

Thank you for your collaboration!

ANNEX 2 - Post-Training Teacher Questionnaire

1. **Country** *

2. **Subjects taught** *

3. **The developed tools can support the achievement of students' learning objectives in STEM education.** *

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

4. **If your previous answer was "Strongly disagree" or "Disagree" ("1" or "2"), please, specify your opinion here below:**

5. **In your opinion, in which way does the use of works of art support students' learning in other subjects across the curriculum?** *

- Providing more stimulating activities
- Favouring students learning by doing
- Supporting students in solving more complex problems
- Providing students with more experience in problem-solving
- Other

6. **If your previous answer was "other", please, specify here below:**

7. **In your opinion, in which way can the use of the mini-game concept design support students' learning in STEM education? ***

- Identifying the right action strategies for scientific context
- Offering wider knowledge of objects, events and phenomena
- Improving the problem-solving strategies
- Increasing students' attention span and motivation
- Other

8. **If your previous answer was "other", please, specify here below:**

9. **Please, try to quantify the potential perception of the proposed methodology by students. ***

	1	2	3	4	5	
Fully not accepted						Fully accepted

10. **If your previous answer was "Strongly disagree" or "Disagree" ("1" or "2"), please, specify the motivations here below:**

11. **Please, evaluate the possible degree of fun for the students in the proposed method. ***

	1	2	3	4	5	
Minimum	◯	◯	◯	◯	◯	Maximum

12. **If your previous answer was "1" or "2", please, specify the motivations here below:**

13. **How do you evaluate the usability of the G.A. STEM methodology and tools? ***

14. Would you like to add something else?

Thank you for your collaboration!

ANNEX 3 - Preliminary Students Questionnaire

1. **Age ***

2. **Gender: ***

- M
- F
- Other

3. **Country: ***

4. **What do you think about scientific disciplines?**

Indicate your answer by selecting a number from 1 (strongly agree) to 5 (absolutely disagree).

4.1 Scientific disciplines are boring. *

	1	2	3	4	5	
Strongly agree						Strongly disagree

4.2 I only use math and science at school or to do my homework. *

	1	2	3	4	5	
Strongly agree						Strongly disagree

4.3 I think math is something abstract. *

	1	2	3	4	5	
Strongly agree						Strongly disagree

4.4 I think science is something abstract. *

	1	2	3	4	5	
Strongly agree						Strongly disagree

4.5 When I finish school, I won't need math and science. *

	1	2	3	4	5	
Strongly agree						Strongly disagree

4.6 I like to attend math and science class. *

	1	2	3	4	5	
Strongly agree						Strongly disagree

5. What do you think of the relationship between mathematics/science and art? Indicate your answer by selecting a number from 1 (strongly agree) to 5 (absolutely disagree).

5.1 I never thought I could study mathematics/science using art. *

	1	2	3	4	5	
Strongly agree						Strongly disagree

5.2 It could be a way to increase my interest in math and science. *

	1	2	3	4	5	
Strongly agree	◯	◯	◯	◯	◯	Strongly disagree

3. Do you know what a game concept is? *

- ◯ Yes (Go to the Question 3.1)
- ◯ No

3.1 Have you ever tried to develop or design a game concept?

- ◯ Yes, many times
- ◯ Yes, few times
- ◯ No, but I would like to try.
- ◯ Never

Thank you for your collaboration!

ANNEX 4 - Follow-up Questionnaire for students

1. **Age ***

2. **Gender: ***

   - M
   - F
   - Other

3. **Country: ***

4. **How did you realize your project work? ***

   - Individually
   - In groups with my mates.

5. **What do you think about combining scientific disciplines and Arts?**

Indicate your answer by selecting a number from 1 (strongly agree) to 5 (absolutely disagree).

5.1 It helped me understand that math/science is not something abstract. *

	1	2	3	4	5	
Strongly agree						Strongly disagree

5.2 I can use my creativity and be original. *

	1	2	3	4	5	
Strongly agree	◯	◯	◯	◯	◯	Strongly disagree

5.3 I don't feel comfortable using this method. *

	1	2	3	4	5	
Strongly agree	◯	◯	◯	◯	◯	Strongly disagree

5.4 The contents learned seem me to be more concrete and practical than before. *

	1	2	3	4	5	
Strongly agree	◯	◯	◯	◯	◯	Strongly disagree

5.5 Using "Artworks" has increased my interest in math and science.

	1	2	3	4	5	
Strongly agree	◯	◯	◯	◯	◯	Strongly disagree

6. How would you evaluate your experience in the mini-game concept design?

Indicate your answer by selecting a number from 1 (strongly agree) to 5 (absolutely disagree).

6.1 Creating a mini-game idea increased my interest in math and science. *

	1	2	3	4	5	
Strongly agree	◯	◯	◯	◯	◯	Strongly disagree

6.2 Creating a mini-game was interesting and funny. *

	1	2	3	4	5	
Strongly agree	○	○	○	○	○	Strongly disagree

6.3 I would like to know more about the mini-game design. *

	1	2	3	4	5	
Strongly agree	○	○	○	○	○	Strongly disagree

6.4 It was easy to create a mini-game concept using the mathematical/science concept studied. *

	1	2	3	4	5	
Strongly agree	○	○	○	○	○	Strongly disagree

Thank you for your collaboration!

ANNEX 5 – Application Form

Organization Name:_______________

Address: ________________________

Attn: ___________________________

I, the undersigned, hereby____________________________, Born in________________________ Date___________,

address____, Town____________________________,

Country_________________, ID Number ____________________________, Expire Date______________________,

Telephone_______________________________Mobile____,

email____

Teacher in ____

REQUIRES

- To participate in the course "**Art and mini-games**" realized in the framework of the Erasmus+ G.A. STEM Project Ref. 2018-1-FI01-KA201-047215.

DECLARES

- To have the following requirements as specified in the **curriculum vitae** attached:

  1. English knowledge (at least B1).
  2. To be a full-time employee for at least one year.

- To be aware that the date of arrival of the requests will determine the registration priority.

- To be aware that data processing is essential for participation in the training course;

- To be aware that the data provided will be processed in compliance with the EU Regulation 2016/679 "General Data Protection Regulation" and with the current national laws concerning personal data protection. The interested party may exercise the rights referred to in Art. 13 GDPR 679/16.

Place and date________________________________ Signature______________________

ANNEX 6 – Mini-game Concept Design Template

G.A.
STEM

MINI-GAME CONCEPT DESIGN

GAME TITLE:________________

Author/s:_____________________

School Name:_________________

Country: _____________________

GAME CONCEPT DETAILS

Please, describe your game idea with the help of a short document by providing short information on the following items:

- Idea description
- Players role
- Learning objective
- Entertaining aspects
- Main challenge
- Genre
- Target audience
- Hardware platform
- Competition/Collaboration mode
- Gameworld
- Unique selling point

GAME CONCEPTUAL MAP

Please, summarize the game idea description by using a conceptual map

MINI-GAME PRODUCTION (OPTIONAL PHASE)

Prototype or Demo

(please, specify if it is available and where it was uploaded):

Co-funded by the
Erasmus+ Programme
of the European Union

THANK YOU FOR YOUR ATTENTION!