INSTRUCTIONAL GUIDE ON GAME-BASED EDUCATION FOR PROMOTING GENDER EQUALITY IN STEAM

Intellectual Output 3

FemSTEAM Mysteries: A Role-Model Game-Based Approach to Gender Equality in STEAM

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Executive Summary:	*FemSTEAM Mysteries* is based on the values of gender equality and non-discrimination between men and women in the fields of Science, Technology, Engineering, Arts and Mathematics (STEAM), creativity and innovative entrepreneurship. Through the adoption of an innovative approach that integrates STEM and Arts, and combines Role-Model and Game-based methodology with a mystery story-telling digital game (escape room) that engages teenagers (age 12-15), *FemSTEAM Mysteries* aims to: (i) bring out the significant role of women in STEAM; (ii) fight stereotypes of students and teachers; (iii) inspire young girls through role-model game-based STEAM pedagogy to follow STEAM careers; (iv) enhance acquisition of key skills and competences for STEAM studies and careers of all students (boys and girls); (v) enhance teachers' skills in dealing with gender equality in STEAM. A main output of the *FemSTEAM Mysteries* project is an instructional guide on game-based education and activities for promoting gender equality in STEAM, with the main objective of fighting stereotypes in STEAM and motivating students (boys and girls) through serious games, game-based activities and tools to participate and collaborate in STEAM. The guide provided insights for the development of the *FemSTEAM Mysteries* game and along with O2 (Instructional guide on role-model education for promoting gender equality in STEAM) and O5 (*FemSTEAM Mysteries* Library and Toolkits) will support teachers to implement the *FemSTEAM* approach in the classroom. The current output includes the following parts: a) A literature review explaining what game-based education is and how it differs from other approaches to integrating games in classroom learning, what is the rationale for game-based education and how it can be implemented in the classroom, and finally, what are some of the challenges and drawbacks of game-based learning. b) Main findings from field research that was carried out in three *FemSTEAM Mysteries* project partner countries (Cyprus, Greece, and Spain) examining teacher and student views, experiences and/or practices regarding the use of games for recreational and educational purposes. c) A collection serious games and game-based activities that can be used in STEAM education d) Ideas on game-based activities for fostering gender equality in STEAM.

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1.2. Introduction

Technological advances have enabled the development of new learning environments and tools, increasing the range and sophistication of possible classroom activities (Meletiou-Mavrotheris & Prodromou, 2016). The use of diverse technological tools can increase student interaction and class participation as well as enable students to test their knowledge and regulate their own learning. Traditional book-based teaching and learning can nowadays be enhanced or transformed through other pedagogical approaches, such as game-based education. The latter allows students to act as players and to engage with the learning content either by using simulations in a digital world or by using tools other than technology. When suitably designed, digital educational games have many potential benefits for teaching and learning at all levels. According to several meta-analysis and research reviews on the impact of games on learning and motivation (e.g. Clark, Tanner-Smith, & Killingsworth, 2014; Lamb, Annetta, Firestone, & Etopio, 2018; Wouters, Van Nimwegen, Van Oostendorp, & Van Der Spek, 2013) game-based education can support higher-order cognitive, intrapersonal, and interpersonal learning objectives and, therefore, it is considered an appropriate approach for STEAM education (Gao, Li, & Sun, 2020).

In this section, a short literature review will be presented aiming at:

- providing a definition of educational games,
- explaining what game-based education is, how it can be implemented, and how it differs from other approaches to game use in the classroom,
- discussing the benefits as well as the challenges and drawbacks of game-based education based on research findings.

1.2. Educational games: what are they?

Educational games are learning environments that have all the characteristics of entertainment games, such as rules and constrains, competition, fantasy, challenge, feedback, user control and continuous interaction, but they have been designed to support specific learning goals (Alessi & Trollip, 2001). Another term that is often used to characterize educational games is the term “serious games”, although there are conflicting views about its exact meaning (Blumberg, Almonte, Anthony, & Hasimoto, 2013). The term “serious games” may be used to refer to games whose entertainment quality is used for educational, training, and communication purposes, and which are more complex than the traditional “drill-and-practice” educational games. However, some scholars include in the category of serious games even commercial entertainment games, such as *World of Warcraft*, that may teach players knowledge and skills (e.g, reasoning and collaboration skills).

Several taxonomies have been proposed to categorize educational games into specific types, in an effort to better understand how the characteristics of each game type may relate to learning. For example, a taxonomy based on a review of the games that are currently being used in educational settings in Greece (Kirstavridou, Kousaris, Zafeiriou, & Tzafilkou, 2020) identified the following main categories: *memory games* and *quiz games* (that assess knowledge and cognitive skills), *puzzles* (that require application of logic, creativity and knowledge), *simulation games* (which do not have specific goals but enable players to explore simulated real-world environments), *strategy games* (that engage players in problem solving that requires strategic thinking, concentration and prediction making), *reality testing games* (that enable players both to see and interact with a virtual world, imagined or real), and *interactive games* (that help learners develop skills in specific content areas such as math and literacy). Another taxonomy presented by Ke (2016) includes *puzzle games* (requiring logical thinking), *action games* (requiring quick thinking and reflexes), *adventure games* (involving constant exploration, puzzle solving and item collection to accomplish a mission), *strategy games* (requiring analysis, planning and strategy deployment to carry out a mission), *role-playing games* (in which players interact with characters and engage in information collection and decision making), *simulation games* (involving interacting with a simulated model or a system), and *construction games* (including design, construction, and resource management).

As it can be seen in the above examples, there is only partial overlap among the various educational game taxonomies and one reason is that it is difficult to differentiate the characteristics of game types (or genres) from each other (Tobias, Fletcher, and Wind, 2014). Some researchers (Gentile, 2011; Ke, 2016) have proposed specific dimensions that differentiate games, which can be used in developing a game taxonomy. Ke (2016) proposed two criteria, which determine how players interact with the game (the *gameplay*). These criteria are (a) the characteristics of game narrative, which includes setting, plot, and characters, and (b) game mechanics, that is, the rules and actions of gameplay. Gentile (2011) discussed four dimensions of gameplay: *the content of the game* (e.g. math game), *the social context* (e.g., whether the game is multiplayer or not and whether players participate in competing teams or compete with each other), *game structure* (i.e. the way the screen of the game is structured to provide useful information, which may be related to the development of players' perceptual and spatial cognitive skills), and *mechanics of the game*. The latter refers to the way players control the game using specific devices and is considered important because the similarity of game mechanics with real-world activities may influence the transfer of game-based learning.

Another game category that is becoming popular is the escape room, which is based on the physical escape room game. Escape rooms are collaborative games in which

players work together to solve puzzles using specific resources and in a limited amount of time, to achieve a common goal that is embedded in a story (Nicholson, 2015). Puzzles may depend on thinking skills and logic, they may involve the manipulation of objects or they may require the solution of other puzzles (Veldkamp et al., 2020). Escape rooms require a diverse set of skills, such as the ability to search for clues and to discern important information, to recognize patterns, and to relate various pieces of information (Wiemker, Elumir, & Clare, 2015). A good escape room enables all team members to contribute to its solution by including a variety of puzzles that require diverse skills.

1.3. What is game-based education?

Game-based learning (GBL) is an innovative approach that uses actual digital games or even traditional games, to enhance teaching and learning and to evaluate learners' knowledge and skill acquisition (Tobias et al., 2014; Plass, Homer, & Kinzer, 2015). In game-based learning, games are not used as tools of entertainment (e.g., as a "reward" at the end of the lesson), but as supporting tools that complement or transform more conventional teaching methods and align with academic syllabi and curriculum materials (Zirawaga, Olusanya, & Maduku, 2017).

There are two approaches to integrating educational game play into the teaching and learning process (Marklund & Alklind Taylor, 2016; Romero & Barma, 2015):

a) Teachers can use existing educational games. The challenge of this approach is to find appropriate quality games (e.g., games that are appropriate for the students in terms of the level of difficulty, the language, the support that is provided) or to find games that can be adapted and customized, to match student needs and curricular goals.
b) Teachers can adapt the learning sequence in order to integrate a commercial off-the shelf (COTS) game (such as *SimCity*) into it, in a way that it serves curricular goals. Specifically, they may use the game in one of the phases of the teaching and learning process, e.g. in the beginning, to introduce new concepts, or in the end for student practice or evaluation (Romero & Barma, 2015). The advantage of this approach is that there are several effective and engaging COTS games, which can help users develop higher order thinking skills (Van Eck, 2009). The challenges of this approach are that students need to be familiar with the game that is used and that it is not easy to integrate a commercial game (which typically is not adaptable) in a way that its use serves specific curriculum and lesson goals and does not distract from learning (Romero & Barma, 2015).

An alternative to the GBL approach is to integrate games in the classroom via *constructionist gaming*, which involves having students create their own games to

achieve curricular objectives, using game authoring platforms and tools such as Scratch (Kafai & Burke, 2015; Romero & Barma, 2015). The advantage of this approach is that in addition to acquiring knowledge and skills in a specific content area (e.g., math), students also develop computational thinking and digital literacy skills. A big challenge of implementing game construction activities, however, is that teachers need to have programming skills to be able to guide students.

An educational approach that may be considered similar to game-based learning is *gamified learning*. However, the two approaches are different. Game-based learning involves playing an actual educational game while "gamified learning", involves augmenting the learning process by adding a few game elements to motivate learners, without however engaging them in game play (Sailer & Hommer, 2020). Such elements include using badges as rewards, ranking students according to their achievements, enabling students to accumulate points and to progress through a hierarchy of levels, and creating challenges toward defined objectives (Dichev & Dicheva, 2017). As Plass et al (2015) explain, although game-based learning may also include points and competition, making a learning activity game-based would also require redesigning the activity using artificial conflict and game rules, to actually turn it into a game. Another important difference between game-based learning and gamified learning is that while games are designed to be intrinsically rewarding, gamified learning motivates students mostly through external rewards and competition.

1.4. What is the rationale for game-based education?

There are several arguments in favour of using digital games as learning tools, most of them pointing to the impact that games may have on student motivation (Blumberg, 2013; Plass et al., 2015). Research has established that when learners are motivated, they are more productive and cognitively engaged in learning: they invest more time and effort, demonstrate persistence and do not quit even when the learning tasks are difficult, and use better strategies to learn, to reason, and to solve problems (Schunk, Meece, & Pintrich, 2012).

Various theoretical perspectives have been used to explain how the specific characteristics of games contribute to their motivational effects (Blumberg, 2013; Plass et al., 2015). One relevant concept is *self-efficacy*, originating in Bandura's social cognitive theory (Bandura, 1989), based on which students are motivated to learn when they think that they are able to accomplish a task or perform a target behavior. Based on this theoretical approach, games can motivate learners by enhancing their self-efficacy, because repeated game play enables players to master content, skills, and target behaviors which are transferable to real-world settings (Blumberg et al.,

2013; Thompson et al., 2010). An important characteristic of games is that they allow learners to fail without having to suffer the real-life negative consequences of failure, which protects their self-efficacy, encourages risk-taking and exploration, and supports the development of self-regulation (Barab, Gresalfi, & Arici, 2009; Plass et al., 2015).

According to another approach, games can enhance learning by making it intrinsically rewarding, because playing a good game is an enjoyable activity. Four features of games that are linked to intrinsic motivation are (a) player's ability to regulate aspects of the game play (control), (b) unexpected outcomes and level of difficulty that is appropriate for player's skills (challenge), (c) the incorporation of narrative elements that are intrinsically related to the skills to be learned, which may make the game personally relevant for learners (fantasy), and (d) curiosity, which is aroused when the game, by providing ambiguous and incomplete information, makes learners perceive that their knowledge is incomplete and inconsistent (Malone & lepper, 1987). Other elements of game play that are linked to their motivational appeal relate to the concept of immersion (Blumberg, et al., 2013), which refers to player's sense of presence within the game, and to the various types of learner engagement (cognitive, affective, behavioral, and social) that games enable (Plass et al., 2015). Finally, according to another relevant perspective good games can produce "flow experience", a situation where players are completely absorbed, highly engaged in an activity (Habgood & Ainsworth, 2011), which happens when four conditions are met (Csikszentmihalyi, 1990): the activity has clear goals and manageable rules, learners have autonomy (they can adjust opportunities for action to their skill level), feedback is provided to inform learners on their progress, and task distractions are minimized.

Research evidence, accumulated over the past years, provides support to arguments linking game-based instruction to increased motivation and learning. As various reviews and meta-analyses of empirical studies have shown, game-based learning tends to be more effective compared to conventional instruction (Boyle et al., 2016; Clark, Tanner-Smith, & Killingsworth, 2016; Lamb, Annetta, Firestone, & Etopio, 2018; Vogel et al., 2006; Wouters, Van Nimwegen, Van Oostendorp, & Van Der Spek, 2013), and is associated with improved content understanding, better retention of information, and the development of "21st century skills" such as problem-solving and social skills. Therefore, educational games, and more particularly serious games, have the potential to advance several STEAM goals, including motivation to learn STEAM content, interest in STEAM fields, and the development of problem solving and inquiry skills (Gao, Li, & Sun, 2020).

1.5. How is game-based learning implemented in the classroom?

Although games have been used in formal and informal educational settings for quite some time, the academic community is still in search for appropriate pedagogical techniques for integrating games in teaching and learning. Research has focused mainly on exploring the theoretical foundations of GBL and on the effects of the approach on learning and motivation and only a small portion of studies examined pedagogical issues (Foster & Shan, 2015). Nevertheless, a few pedagogical frameworks have been proposed to guide the design of game-based learning and there have been several empirical studies examining how game-based learning is implemented in the classroom.

Pedagogical frameworks (Arnab, et al., 2012; Foster & Shan, 2015; Van Eck, 2009) tend to emphasize that GBL should create opportunities for problem-solving and inquiry activities, to engage students actively in learning and to enable the development of higher-order cognitive skills. It is therefore critical that teachers select games carefully, so that they can support these types of learning. When selecting COTS this can be challenging because teachers need to look for complex games that engage students in collaborative problem solving but at the same time make sure that a significant part of the game is relevant to the instructional goals (Van Eck, 2009). Also, learning activities should be anchored in the game and designed in a way that supports higher level thinking processes such as inquiry, creation of artifacts, communication of ideas and self-expression (Foster & Shah, 2015). Further, Van Eck (2009) recommended that activities extend the game, meaning that they are authentic to the game world (e.g., new problems or extensions of game problems), although teachers should create opportunities for connecting what was learned in the game world to the real world (such as debriefing and reflection activities after game play). Similarly, it is recommended that teachers use authentic evaluation methods that address all aspects of learning as well as student motivation and attitudes (Van Eck, 2009).

Bado (2019) carried out a systematic review of 46 empirical studies which examined the implementation of game-based learning in the classroom. Three groups of activities emerged from the analysis: pre-game, game, and post-game instructional activities. Pre-game activities prepare students for game play and aim at familiarizing them with game content and technology. For example, teachers may provide a brief demonstration or ask students to watch a video tutorial on how to play the game, and then allow students to acquaint themselves with the game. Teachers may also use mini-lectures to provide students with background content knowledge relevant to the subject of the game and/or supply additional sources that will support their game play and learning, such as reading materials, worksheets, and game guides. Instructional activities during game play include providing scaffolding and technical support to

students as well as applying classroom management techniques such as giving instructions on how students should form groups and how to collaborate, or checking whether they are on-task and contribute to the game play. Post-game activities implemented after game play aimed at reinforcing learning and included debriefing and reflection activities. Debriefing took place in the form of guided discussions that helped to clarify possible student misunderstandings and encouraged students to make connections with prior knowledge and curriculum content and to think of applications of new knowledge to other contexts. Reflection activities required students to respond to questions or topics provided by the teacher, either orally in class or in writing. Bado (2019) noted, however, that in the studies he examined, most teachers did not use post-game activities although debriefing and reflection can maximize student learning outcomes.

1.6. Drawbacks and challenges of game-based education

Game-based learning has several advantages, research, however, has also documented drawbacks and challenges in its classroom implementation. Some of these are presented bellow.

- *Parental and teacher concerns about games and game-based learning*

  Parents, teachers, and other educators are often sceptical regarding the effectiveness of this learning approach because they doubt whether students are benefiting from it or worry that GBL techniques are distracting them from their studies (Kirstavridou et al., 2020; Romero & Barma, 2015). Also, some teachers worry about the long-term impact of games on student development due to the blurring of lines between fantasy and reality in virtual worlds (Dickey, 2015). Another concern is that when game play is assigned to and not chosen by the students games will be less enjoyable and therefore they will have limited contribution to student motivation and learning (Dickey, 2015).

- *Participants' technology learning curve*

  There is a technology learning curve that needs to be taken in consideration when designing GBL activities. According to Pratama and Setyaningrum (2018), students play games at a different speed, and therefore may also progress in the game at different speed. Subsequently, students who are less adept at playing games might find themselves unable to participate in the learning process. Pratama and Setyaningrum (2018) argue that this problem will be resolved if time is given to these students, and they are provided with support when game-based learning activities are implemented.

- *Difficulties in finding games that are aligned to instructional goals*

  While there is a wide variety of games available within educational context, teachers often point out that it is not easy to find good quality games that relate to specific learning topics (Kirstavridou D. et al., 2020). Also, it is important for teachers to

consider whether a particular technological tool or game is being used in a learning scenario for the sake of using technology or if it is used because it improves learning and enhances the lesson (Pho & Dinscore, 2015). The SAMR (Substitution, Augmentation, Modification & Redefinition) model designed by Puententura (2006) is an excellent tool to consider when designing a GBL.

- *Logistics*

  A typical school day is organized around short class periods. This makes it hard to integrate games in the classroom because they usually take longer to play. Also, in many schools it is not easy to provide students with access to computers or portable devices for game play (Klopfer, Osterweil, & Salen, 2009).

- *Need for teacher professional development regarding GBL*

  Most teachers have limited experience in game-based learning and therefore lack the vision of how it would look like in the classroom (Klopfer, 2009; Meletiou-Mavrotheris & Prodromou, 2016). It is therefore important that teachers are provided with professional development that would address topics related to pedagogy, such as the selection of quality educational games, the design of appropriate learning activities, and ways to support students (Meletiou-Mavrotheris & Prodromou, 2016).

1.7. How to choose a game?

The use of games in teaching and learning is undoubtably proven to be useful as stated in the previous sections of this report. There is currently a vast documentation with myriads of gaming resources ready to be implemented in an educational context. How can a tool be chosen though amongst others? And how can we be sure which tool to use in which case? A game-based tool might be ideal in one learning activity, but at the same time it might be completely irrelevant in another. It will take some experimentation for a teacher to provide his/her own answers to the above questions. However, there are some simple rubrics or frameworks to facilitate this process for educators. One such framework is provided on pages 40-43 of the report by McFarlane and Sparrowhawk (2002). Although not all of the criteria included may be relevant to each game type, most of them address important issues that need to be considered.

2. Survey results: Perceptions and experiences relative to game-based education

As part of the Erasmus+ Programme "FemSTEAM Mysteries: A Role-Model Game-Based Approach to Gender Equality in STEAM" we carried out two surveys involving the teachers and students of the 3 project partner schools in Cyprus, Spain, and Greece. The purpose of the surveys was to better understand the backgrounds, experiences, and views of our target populations and to gather information that would help us develop the methodological guidelines of the FemSTEAM Mysteries project. In the next sections we present the methodology and the main findings of the teacher and student surveys.

2.1. Teacher survey methodology

The teacher survey was developed in English. It contained one section on demographics and 8 other sections that addressed past experience and/or beliefs on: STEM/STEAM education; gender and education; game-based learning; gender differences in STEM/STEAM; current teaching practices and STEM/STEAM related teaching practices; current teaching practices and gender; instructional use of games; needs and recommendations. Nearly all questions were Likert-type or multiple-choice, to make it easy for teachers to complete the survey and respond to all questions.

The questionnaire was posted electronically via Google forms and it took about 20-25 minutes to complete. It was administered to teachers in the three partner institutions: American Academy Nicosia, Cyprus; La Salle Buen Consejo, Spain; and Doukas School, Greece. Invitation messages explaining the purpose of the study and providing a link to the survey were sent via email to all teachers in these institutions. Participation was completely voluntary and anonymous. No identifying information was collected from participants.

A total of *39* teachers (28 female and 11 males) completed the survey: *16* teachers from American Academy Nicosia in Cyprus (*41.0%)*; *13* teachers from La Salle Buen Consejo in Spain (*33.3%)*; and *10* teachers from Doukas School in Greece (*25.6%)*. The majority were aged between 30-49 (*n=32, 82.1%*) and had been teaching for more than 5 years (*n=32, 82.1%*). Also, the large majority (*n=30, 76.9%*) had a Master's degree and many of them (*n=10, 25.6%*) had worked in the industry.

In the next sections we present the main findings of this survey that are relevant to teacher views about game-based learning and the instructional use of games. Data on teacher responses to the other sections of the survey are excluded from this Intellectual Output because they are presented in Intellectual Outputs 1 and 2. Also, due to the small number of participants, no comparisons between institutions/countries were carried out.

2.2. Teacher perceptions on game-based learning

Teachers almost unanimously, agreed/strongly agreed that game-based learning should be used in educational practice (94.8%) and that game-based activities make the learning process enjoyable (97.4%), while at the same time also promoting higher learning (92.3%), and the development of students' 21st century skills (89.7%). The majority also agreed that it is easy to monitor students' progress when incorporating game-based activities (74.4%) and that it is easy to assess students through gaming platforms (58.9%). Only around one-fourth responded that game-based activities can distract students' attention away from learning (23.1%), that they take too much class time which is not always worth it (23.1%), or that the use of electronic games for non-educational purposes has a negative effect on student behaviour (25.6%) and/or academic performance (30.8%).

2.3. Teacher instructional use of games

Most teachers (n=28, 71.8%) responded that they use game-based learning activities in their classroom. These 28 teachers were prompted to indicate what categories of games they used in their classrooms with their students. The game categories most frequently used by teachers were trivia (n=16) and simulations (n=14). Smaller numbers of teachers used riddles (n=9), adventure (n=7) and/or strategic games (n=7). Only 4 teachers introduced games making use of augmented reality, while no teacher used a role-play game. As expected, a very small number of teachers used action (n=5), sports (n=3), or battle (n=1) games.

The 11 teachers reporting no use of game-based learning activities in their classroom were asked to explain their response by indicating their level of agreement with each of a series of statements. Only two of the teachers not currently using games, agreed that game-based activities are not appropriate for the subject(s) or the grade level that they taught. Most of them indicated that they would like to use game-based activities, but they do not because this would require a lot of time to prepare and/or to implement in the classroom. The majority (7 out of 11 teachers) also expressed an interest in professional development on game-based learning.

Teachers were also inquired about the methods they used to assess student performance with/around digital games. Five teachers stated that they did not assess students' performance with or around digital games. Teachers assessing student game-based learning, did so mainly through the administration of their own tests/quizzes (n=16), through class discussion (n=14), and/or by taking students' game performance (e.g. scores) into account (n=13). Only 8 teachers stated that they use learning analytics provided by the game.

At the end of the survey, teachers were asked to list the titles of game-based platforms they were using with their students and that they recommended for other teachers. The most popular platform recommended by most of the teachers was Kahoot, followed by Quizizz and Quizlet. A few teachers also recommended Scratch as a tool for game creation, and Minecraft.

2.4. Student survey methodology

To understand the background and beliefs as well as the school and out-of-school experiences of adolescent students (ages 12-15), a survey was carried out in the three partner schools of the FemSTEAM Mysteries project, located in Cyprus, Spain, and Greece. An instrument was developed in English which, in addition to demographics, addressed the following topics: knowledge on STEM/STEAM studies and careers; after-school activities; school practices on STEAM; perceptions about STEAM studies and careers and of men and women in STEM/STEAM; use of games in daily life and at school. Nearly all questions were Likert-type or multiple-choice, to enable students to complete the survey in about 20 minutes and without leaving unanswered items. The instrument was developed and posted electronically via Google forms. Invitation messages explaining the purpose of the study, and providing a link to the survey, were sent via email to all teachers in the three institutions. Participation was completely voluntary and anonymous. No identifying information was collected from participants.

A total of 361 students responded to the survey from the three partner institutions: 102 students from American Academy Nicosia in Cyprus (*27.98%)*; 165 students from La Salle Buen Consejo in Spain (*45.7%)*; and 94 students from Doukas School in Greece (*26.04%)*. Fifty-three percent of the respondents (*n=190*) were male, 42 percent female (*n=152*), while the remaining 5 percent either identified themselves as "Other" (*n=8*) or selected "I prefer not to respond" (*n=11*).

In the next sections we present the main findings of this survey that are relevant to student views about the use of games in daily life and at school. Data on student responses to the other sections of the survey are excluded from this Intellectual Output because they are presented in Intellectual Outputs 1 and 2. Also, the fact that the survey study was conducted in only school per country, as well as the self-selected nature of the sample, made the collected data unsuitable for comparisons between institutions/countries. Thus, we chose to analyse the whole sample data across as a single cohort irrespective of affiliation.

2.5. Student use of games in daily life

In the survey students were inquired about their level of use and attitudes towards the use of games in their daily life. Their responses confirmed that using games was an activity that had a prominent presence in their daily life as the majority (67.59% of all students, 68.9% of boys and 52.6% of girls) stated that they enjoyed playing games. Also, sixty-three percent (63%) of the students reported playing games daily or at least 2-3 times a week, while three-fourths (74.5%) played at least once a week. However, there were important gender-related differences in the frequency of game-playing. While almost eighty percent of male students (77.9%) played games at least 2-3 times a week, the corresponding percentage for female students was 43%. While only 8% of the boys reported rarely or never playing games, 28% of girls reported that they rarely or never play games.

Around half of the students (51.0%) indicated that playing digital games is an activity that took up a lot of their time. Students stated that they mainly use their PCs (47.5%), gaming platforms (45.2%), and/or their smartphones (42.0%) and their tablets (22.2%) to play games. The types of games that most students usually play are action (60.9%), battle (60.9%), and/or adventure games (55.4%). About half of the students play strategic games (47%) and around one-third reported playing sports games, and/or simulation-based games. Only a short proportion of the students (12.0%) play games in the form of riddles. When students were asked to note the names of two of their favourite digital games, they referred to many different games including Among Us, Subway Surfers, Animal Crossing, Minecraft, Assassin's Creed, Brawl stars, Fortnite, FIFA 21, Call of Duty, Formula I, Legends, Clash Royale, League of Legends, and Super Mario.

Playing games was an important leisure time activity for the participants, with half of them reporting spending at least 6 hours per week on games. One-fourth (24.9%) spend more than 11 hours per week playing games. Male students tended to spend more time on games than females. For example, 18% of the boys vs. none of the girls stated spending more than 20 hours on games per week.

Finally, students were asked to indicate how they think the use of electronic games affects their behaviour and school performance. Forty-two percent (42%) of the students argued that the use of digital games does not have any effect on their behaviour and school performance. Eleven percent (11%) thought that game playing had a negative influence on their behaviour and school performance while 16% thought that playing games had a positive effect. Finally, twenty-six percent (26%) argued that game playing affects them both positively and negatively.

2.6. Student views about the use of games at school

When students were asked to indicate their level of agreement with several statements regarding the use of games at school their responses tended to express positive attitudes. The majority agreed that playing games in class can make the learning process joyful (77%), can improve their attitudes towards learning (62.3%), and can also help them develop their problem-solving strategies (59.3%) and their critical and creative thinking (63.5%). Only a small proportion of students gave responses indicating that they did not wish or did not find it appropriate or constructive for teachers and students to use digital games in class.

Only 30% of the students indicated that their teachers often asked them to use digital games. The remaining 70% stated that their teachers rarely or never ask them to use digital games in class. The subjects having the highest percentage of reported instructional use of games were Computing, Science, English, Maths, Greek, and Music (above 20%). Smaller percentages of students reported instructional use of games in all other subjects. Almost twenty percent of the students (18.6%) stated that electronic games were not used in any of their subjects.

Based on student responses, the game categories most frequently used by teachers were trivia (38.2%), strategic games (22.2%), riddles (18.6%) and simulations (17.7%). A much smaller percentage of students (less than 10%) reported that their teachers made use of sports, augmented reality, role-play, battle, adventure, quiz-type, and action games.

Finally, when students were prompted to describe the feature that they would want an educational digital game to have, their responses tended to include the following characteristics or elements: entertaining, dynamic, team play, competition, strategy, reasoning, creativity.

3. Game-based suggested tools

Game-based learning tools may introduce games in the classrooms to improve student performance, motivation, concentration, and effort. Some of the game-based educational tools that exist and are being used in educational settings in Spain, Cyprus, Greece and Germany are listed below:

3.1. Math City Math

Suggested Gaming Tool/Resource: https://mathcitymap.eu/es/

Type/Category: Math trials

Areas we can apply it: Mathematics, Science, Technology and Art

Cost: Free

A few words about the tool: MathCityMap is a two-component system. The first component is a webportal (www.mathcitymap.eu) which serves as an open access database for authentic math problems in the environment. The other component, the MCM-App, shows on a map where in the environment the problems are hidden. Additionally, it provides hints, feedback and a sample solution. To solve such an authentic MCM problem you need mathematical modelling competencies. MathCityMap is a project that combines the idea of math trails with the capabilities of smartphones. MCM brings math education outside using technology!

3.2. The Camera Obscura

Suggested Gaming Tool/Resource:

- Geogebra www.geogebra.org
- TinkerCad www.tinkercad.com

Type/Category: Project Based Learning

Areas we can apply it: Mathematics, Science, Technology and Art

Cost: Free (scrap and low-cost materials)

A few words about the tool: The students would build a camera obscura, learn its history as well as the basic features of geometrical optics. Another objective is to understand the optical functioning of the eye and to perform experiments related to binocular vision. The students work on content, procedures and skills related to proportionality (in the mathematics discipline), light and the physiology of the eye (in the science disciplines), the design and construction of spherical surfaces from flat materials (in the technology discipline), and photography (in the art discipline).

3.3. Can we repopulate our town with birds?

Suggested Gaming Tool/Resource:

- Geogebra www.geogebra.org
- Moovly www.moovly.com

Type/Category: Project Based Learning

Areas we can apply it: Mathematics, Natural Sciences and Technology.

Cost: Free (scrap and low-cost materials)

A few words about the tool: The objectives are to design, build and install nest boxes in a barren area around the school and study the behaviour of the new tenants. The construction of the nest boxes involves designing, calculating the amount of material to be purchased and building. A video camera is also installed inside one of the nest boxes and the habits of the birds and the young that inhabit them are studied for a period of time. As a result, the students should become aware that individual actions can help to recover the fauna and ecosystem of an area.

3.4. Can we access the school with a wheelchair?

Suggested Gaming Tool/Resource:

- Geogebra www.geogebra.org
- TinkerCad www.tinkercad.com
- SketchUp www.sketchup.com

Type/Category: Project Based Learning

Areas we can apply it: Mathematics, Art and Technology.

Cost: Free

A few words about the tool: The objectives are to design and build an accessibility ramp to bridge an architectural unevenness in an old school, to comply with the current accessibility regulations for new buildings. The idea is to search the internet for current accessibility regulations, take measurements, design a plan of the ramp, build a model (on a 3D printer or with manipulative materials) and, if possible, actually build it. This activity can be a design and creativity challenge in cases where space is limited. As a result, the students should become aware of the difficulties that wheelchair users have in accessing some public spaces and try to see the world from an inclusive perspective.

3.5. Construction of a domotic house

Suggested Gaming Tool/Resource:

- Geogebra www.geogebra.org
- Scratch https://scratch.mit.edu
- TinkerCad www.tinkercad.com

- Simulation tool: CrocClips

Type/Category: Project Based Learning

Areas we can apply it: Mathematics and Technology.

Cost: Free

A few words about the tool: The objective of this activity is to use these tools to design and build a model of a home automation house programmed with Arduino. Here, students design and build a model of a house (with a 3D printer, or other materials), discuss and decide which sensors they want to program, install an Arduino board and sensors and finally program them with Arduino or Scratch for Arduino. As a result, the students should see the opportunities that home automation provides in our daily lives and how it can increase the autonomy of people with reduced mobility.

3.6. Arlant

Suggested Gaming Tool/Resource: Arlant app

Google Play Link:

https://play.google.com/store/apps/details?id=com.apprender.arlant&hl=en&gl=US

Type/Category: Science skills-based learning

Areas we can apply it: Science, Technology and Maths

Cost: Free

A few words about the tool: You can discover the parts of the plant by working with an impressive 3D model that you can project using augmented reality whenever you want.

3.7. Merge cube

Suggested Gaming Tool/Resource: https://mergeedu.com/cube

Type/Category: Virtual and augmented reality

Areas we can apply it: Science, Technology and Maths

Cost: The cube must be purchased ($19.99)

A few words about the tool: This tool lets you hold digital 3D objects, enabling an entirely new way to learn and interact with the digital world.

3.8. Educational games Nobel Prize

Suggested Gaming Tool/Resource:

http://educationalgames.nobelprize.org/educational/

Type/Category: Si

Areas we can apply it: Science, Technology and Maths

Cost: Free

A few words about the tool: You can find some educational games and animated interactives, based on Nobel Prize-awarded achievements.

3.9. Welt en Der Werk Stoffee (Worlds of Materials)

Suggested Gaming Tool/Resource: https://www.welt-der-werkstoffe.de

Type/Category: Application and Analysis

Areas we can apply it: Material Science, Technology

Cost: Free

A few words about the tool: Worlds of Materials is a point-and-click adventure for students of various engineering courses and those interested in materials science. The game presents the players with entertaining challenges that they must use their basic knowledge of materials technology to solve. The player must use the knowledge from the ten chapters of the basic lecture series. The game design adheres closely to the curriculum, but always takes up the content of the previous chapters. The aim is to reach levels three (apply) and four (analyze) of Bloom's taxonomy.

3.10. SERENA SUPERGREEN and the broken wing

Suggested Gaming Tool/Resource: https://serena.thegoodevil.com/play/

Type/Category: Solve-in tasks

Areas we can apply it: Work-economy-technology

Cost: Free

A few words about the tool: In the serious game "Serena Supergreen", the avatar has to solve technical tasks that an electronics technician, IT specialist or mechanic in the field of renewable energies has to deal with. In the foreground of the game, however, are the adventures of Serena and her friends. More technical ability is, so to speak,

the unexpected "side effect" of the game. In the game, a female avatar who masters technical tasks facilitates such professional identification. In this role you can playfully break down prejudices against technology and take courage to solve technical problems without male help.

3.11. Minecraft education

Suggested Gaming Tool/Resource: https://education.minecraft.net/en-us/homepage

Type/Category: Problem-solving

Areas we can apply it: Marine biology, Social & Emotional Learning (SEL), Equity and Inclusion, ancient history, space exploration, chemistry and more

Cost: 5 euros per year

A few words about the tool: Minecraft: Education Edition is a game-based learning platform that promotes creativity, collaboration and problem-solving in an immersive digital environment. Educators around the world use *Minecraft: Education Edition* to engage students across subjects and bring abstract concepts to life. *Minecraft: Education Edition* provides hundreds of standards-aligned lessons and STEM curricula, lessons on digital citizenship, social-emotional learning and equity & inclusion, educational tools, how-to-play tutorials and inspiring build challenges.

3.12. FEMALES game

Suggested Gaming Tool/Resource: https://www.femalesproject.eu/

Type/Category: e-Learning Platform

Areas we can apply it: Women role in STEM

Cost: Free

A few words about the tool: e-Learning platform-MOOCs which will support teachers to learn about the women's role in STEM. They can reach the educational tools from the MOOCs and it will elaborate clearly the tools and activities and the ways teachers can use them to empower or get awareness of their students.

3.13. WoMen in science- The Video Game

Suggested Gaming Tool/Resource:

https://store.steampowered.com/app/1097210/WoMen_in_Science/

Type/Category: Sandbox

Areas we can apply it: Biotechnology (hydroponics, aquaponics, genetics, ...), Electronics (build drones and robots), Food Chemistry (Fermentation, Smoking, Sous-Vide cooking, ...) and Biointensive Agriculture (permaculture, bio control, ...)

Cost: 12,99 euros

A few words about the tool: Building and customizing a farm. Joining a community of epic scientists. Automate tasks, program robots and race drones. The goal is for the students to be able to maximize the productivity of their farms without harming the environment.

3.14. Top Female Scientist game

Suggested Gaming Tool/Resource: http://imgur.com/gallery/SKM8B

Type/Category: Card Game

Areas we can apply it: Physics, Biology, Chemistry, Math, Natural Sciences

Cost: Free

A few words about the tool: The 'Top Female Scientist card game' features 32 of the most celebrated and distinguished names in maths, natural sciences, physics, chemistry and biology. By comparing the scientists based on their achievement, impact, obscurity and 'badassery', the goal of the game is to determine who can be considered the ultimate female scientist of all time.

3.15. Who is who game about extraordinary women

Suggested Gaming Tool/Resource:

https://www.kickstarter.com/projects/playeress/whos-she-a-guessing-game-about-extraordinary-women

Type/Category: Guessing game

Areas we can apply it: Promoting women in STEM

Cost: 65 euros

A few words about the tool: This is a two-player tabletop game about courageous women who changed the world. Clever icons printed on the board give you a quick summary about their life stories. Guess their identity by asking about their accomplishments, not their appearance, with questions like: Did she win a Nobel Prize? Did she make a discovery? Was she a spy?

4. Suggested activities based on game-based education, role models and STEAM

When their forces combined, Science, Technology, Engineering, Arts, and Mathematics (STEAM) are a super group of essential subjects that lead to long-lasting learning. Specific activities based on game-based STEAM education and serious games that enhance gender equality in STEAM increases critical thinking, broadens perspectives, andchallenges misconceptions. This constructivist type of learning builds a culture of students willing to tinker and remix with confidence.

In this section we present a variety of activities which are based on game-based education, role model education and the STEAM approach, designed by teachers in the FemSTEAM project partner schools. For each activity information will be provided to enable their implementation and evaluation in other school settings. Specifically, the presentation of each activity includes: activity title and scope, number of participants, participant selection, description of the activity, specific materials needed to implement it, evaluation sheets for teachers, evaluation sheets for the students.

4.1. Lesson Plan / Activity 1

Title and scope of activity: Escaping the Pythagorean Virtual Museum

Duration: 6 hours

Year Group: Grade 8 (13 years old)

Number of participants: Maximum of 30 students

Gaming element: The gaming element is an Escape Room that students should construct in a Virtual Reality environment created using the coSpaces museum.

Previous knowledge: Students need previous knowledge of 2D geometric shapes (triangles and rectangles), integer and decimal numbers. Although it is not compulsory to have previous knowledge on building constructions or coding, skilled students could deepen their knowledge.

Description of activity: The activity consists in designing and creating an Escape Room in a Virtual Reality environment that emulates a museum of the Pythagorean School. This ancient Greek school is known for its equal rights in democratic participation of men and women, being Pythagoras of Samos and Theano of Crotona two historic role models. Students in teams of four or five students are asked to design and create the Pythagorean Virtual Museum, to play and escape from the museum created by the other teams and co-assess those museums.

The activity has different tasks to be able to Escape the Pythagorean Virtual Museum. Each activity is linked to its description.

Task 1: Motivation

Task 2: Proofs of the Pythagoras' theorem

Task 3: Applications of the Pythagoras' Theorem

Task 4: Theano of Crotona and the Golden ratio

Task 5: Escaping the Pythagorean Virtual Museum

Task 6: Assess your learning

Two linked documents will help teachers and students to create and play with the game "Escaping the Pythagorean Virtual Museum".

- Document for the teachers: O3_FemSTEAM_VTM_teachers
- Document for students: O3_FemSTEAM_VTM_students

Specific materials needed: A computer or a tablet with internet access and Drawing materials

Digital Extension: The digital programs used are: Geogebra, drawing software, image editing programs, videoediting programs, coSpaces Virtual Reality environment,

Evaluation for teachers: The document for teachers includes all the information about the evaluating and marking process included in the next rubric:

O3_FemSTEAM_MPT_Rubric of assessment.pdf

Example of a museum created by students: https://edu.cospaces.io/EXR-QAG

Evaluation for students:

Two forms for students' evaluation are included in the document for the teacher and the document for the students. Those are:

- Co-assessment of the game: https://forms.gle/NMr3Y8GNTRoU8Q1H8
- Assessment of the knowledge, FemSTEAM beliefs and self-assessment: https://forms.gle/SdkHg5HYWRrwf2uV8

4.2. Lesson Plan / Activity 2

Title and scope of activity: Winning the competition!

Innovation of a homemade hovercraft prototype.

Duration: 6 hours

Year Group: Grade 7 (13 years old)

Number of participants: Maximum of 30

Gaming element: The activity is a combination of physical and digital activities.

Digital software to construct the knowledge to play with the gaming elements.

- Google Educational Affordances: Search, Drive storage, Classroom, Docs, Calc, Form, Jamboard, Drawing.
- Geogebra.

Digital games:

- Escape Room Genially.
- Quizizz.

Previous knowledge:

The student should know basic knowledge about instrumental measurement, uniform rectilinear motion (movement), and forces of nature such as weight. They will need to be capable of integrating the STEAM knowledge developed during the process of constructing a homemade hovercraft and investigate using the scientific research and knowledge construction methodology.

Description of activity: Students will work on teams of four or five to construct the hovercraft with the aim of winning the competition.

The activity includes:

- Researching on Internet,
- hands on activities to construct and reconstruct the homemade hovercraft,

- problem solving to integrate STEAM knowledge,
- reflection on the scientific methodology to improve their homemade hovercraft, and
- evaluation, self-evaluation and co-evaluation of the learning process.

The activity includes two documents:

- Document for the teacher: FemSteam Hovercraft_teachers
- Document for the students: FemSteam Hovercraft_students

Specific materials needed:

- Tablet, mobile phone or laptop for accessing the software, Internet Cloud or Google Educational Affordances.
- Physical material to construct the homemade hovercraft:

Digital Extension:

Using Google Site affordances to create students' own presentation of the process of the scientific method applied to construct the homemade hovercraft.

Evaluation for teachers:

Objectives:

- Interpreting the information on scientific issues of an informative nature that appears in publications and the media,
- Developing small research projects in which the application of the scientific method and the use of ICT are put into practice.

Rubric: https://docs.google.com/spreadsheets/d/1sS_vBnLvsW-YsajMUdAbkg2JA_UsweQkT_mHSrhn_7k/edit?usp=sharing

Example of execution:

https://sites.google.com/lasallebuenconsejo.es/aerodeslizador/grupo-b/grupo-4

Evaluation for students:

- Evaluation of the learning process: https://quizizz.com/JOIN?locale=es

- Self and co-evaluation: https://docs.google.com/forms/d/e/1FAIpQLSdIU1pGQOz1Ff9lUe5Tda52WUrIOElyZPgrObNRVRVv7tB1dg/formrestricted

4.3. Lesson Plan / Activity 3

Title and scope of activity: Net of lies

Duration:10 sessions of 60 minutes

Year Group: Grade 10

Number of participants: Maximum of 30

Gaming element: The whole activity uses a gaming element through different digital affordances described in the activity.

Previous knowledge: The game aims to help students to construct the analytical characteristics of the functions through engaging students in a game.

Description of activity:

The game consists in finding out which is your character in the story, and which are the characters of the other players using investigating roles to research the likes and dislikes of each person in the game.

The game begins with a figure of the corpse on the floor, with QR codes scattered all over the crime scene, which is the laboratory.

Specific materials needed: The resources needed are a computer and mobile and physical drawing materials.

Digital Extension:

- QR Codes
- Geogebra
- CoSpaces Virtual Reality Scratch programming
- Google Education affordances

Evaluation for teachers:

Teachers have the description of each activity with its aims and gaming procedures described in the google docs that can be found in the link: Net of lies_teacher

Evaluation for students: Net of lies_teacher_students

4.4. Lesson Plan / Activity 4

Title and scope of activity: Who is she: tabletop game

Learn extraordinary women and their accomplishments and promote gender equality in class.

Duration:48 minutes

Year Group: age 10+

Number of participants: The game is played by 2 people, or can be played by two teams changing persons in each guessing game. But it is more convenient for small groups (up to 10 people).

Previous knowledge: No previous knowledge is needed.

Description of activity:

Task 1 (5 min)- Preparation: The teacher/facilitator/educator selects 10 cards from the game FEMALES and print them 2 times

Task 2 (3 min): The teacher/facilitator/educator divides the class in 2 teams and in each team she/he gives one print of the cards so as in both teams students holds the same cards

Task 3 (10 minutes): The teacher/facilitator/educator introduces the activity and especially the game instructions to the students/participants. The players must guess the identity of women by asking about their accomplishments and not by their appearance (as in the well-known classic version of who is he?).

Task 4 (15 minutes): The students/participants play the game as many times as they can in the given time.

Task 5 (15 minutes): The students are encouraged to choose their favorite personality role-model and present it to the class

Task 6 - after lesson activity: The students/participants are encouraged to research more about their role-model and present through a powerpoint or other means the most important fields of their work.

Specific materials needed: Cards of the game FEMALES (can be printed online)

Evaluation sheet for teachers:

1. Was the activity easy to implement?

2. Did your students enjoy playing the game?
3. Did they get interested to research further about the personalities featured in the game?
4. Did the students remember some of the personalities after the activity?

Evaluation sheet for students:

1. Did you enjoy the game?
2. How many names of women can you recall from the game?
3. Were you interested to search more about the women featured in the game?
4. Did the game change your opinion about the potential of women in STEAM?
5. Did you see any woman featured in the game as a role model?
6. Did the activity motivate you to get engaged in science or other professions for yourself?

4.5. Lesson Plan / Activity 5

Title and scope of activity: Debate

Learn about the contributions and challenges of women working in STEAM

Duration: 20 min preparation

Year Group: age 12-18

Number of participants: Any, preferably in small groups in front of the whole classroom

Gaming element: The gaming element is a board game.

Previous knowledge: No previous knowledge is needed.

Description of activity:

Task 1 (20 min)- Preparation: The teacher/facilitator/educator selects some female personalities in STEAM and downloads some material regarding their life and contribution as well as obstacles she faced.

Task 2 : The teacher/facilitator/educator gives to each student material relevant to one personality. S/he also gives some instructions to the students on what to do.

She/he explains that each student should read the information about his/her personality. The she/he will come forward with a group of other 4 students and will try to combat their theories through a debate.

Task 3: The students prepare themselves for the debate. If extra research needs to be done it is allowed but only if this is the case for all students.

Task 4: The teacher selects who will come for the 1st debate then for the second etc. S/he also poses some questions. Students can also pose some questions.

Task 5: The students score who wins each debate.

Task 6 - after lesson activity: The students/participants are encouraged to do more extensive research about the personality given to them and come back with more details to present to the classroom

Specific materials needed: Material downloaded from internet for each personality

Evaluation sheet for teachers:

1. Was the activity easy to implement?
2. Did your students enjoy playing in the debate?
3. Did they get interested to research further about the personalities given to them?
4. Did the students remember some of the personalities after the activity?

Evaluation sheet for students:

1. Did you enjoy the debate?
2. How many names of women can you recall?
3. Were you interested to search more about the women featured in the game?
4. Did the game change your opinion about the potential of women in STEAM?
5. Did you see any woman featured in the game as a role model?
6. Did the activity motivate you to get engaged in science or other professions for yourself?

4.6. Lesson Plan / Activity 6

Title and scope of activity: Building the school of the future

Duration: 180 minutes[3-4 x 45 mins lessons]

Year Group: Any KS3 - Lower Middle School Class

Number of participants: Maximum of 25

Gaming element: Minecraft Education Available Resource: https://education.minecraft.net/lessons/stem-classroom

Tablet and Desktop versions available

Objectives of activity:

- Construct a structure for their school (design) in the future
- Design the building in a way to reduce the consumption of electricity,
- Calculate the area of the structure and the fund needed to construct it.
- Enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology

Previous knowledge:

The students should:

- Be aware about the 17 SDGs (https://www.un.org/sustainabledevelopment/sustainable-development-goals/)
- Understand that by re-designing the building they can provide different solutions to reduce the use of electricity, or reuse water.
- Be aware that they can use rain water in other facilities of the building
- Be triggered to think of a way to solve real life common problems based on the SDGs

Description of activity:

Students work collaboratively to design a school they envision that must be sustainable. This project will additionally be related to the historic event of the

school's centennial anniversary. To start with this project, two students are assigned as project partners to draft and share ideas.

Following the engineering design process, students will be able to **state clearly the problems** that they wish and want to change if they build their dream school by observing and going over their current school. Moreover, students will also be taking some notes and **sketching the school interior and exterior**. This will help them in estimating the **measurements**.

After their observation tour, each of the groups will be able to focus on how to overcome and improve the build.

They are advised to work in creative mode and document the drawings (draft) before starting to work on Minecraft and document all the constructing phases using the book and quill.

Requirements for the students' projects:

- Has a futuristic design that contains sustainable solutions that is related to the SDG 17.
- The designed structure must be sustainable through clearly stated material choices.
- Students used the book and quill to document the process of their learning journey including the material choice, area of the school. They also state the scale they have constructed the school on.
- Students also document the cost of the resources they used in constructing the building following the discussed cost of each material (teacher can set the cost of each of the blocks).

STEAM defined objectives:

- History - Protect the history of the school as you redesign it
- Languages - Essay theme - Future Society
- Computing - Creating digital content
- Science - Materials/Estimation of building
- Art - Sketch, design of building [scale design, drawing of still objects]

- Mathematics - Estimating measurements -
- Economics - Managing budget restrictions.
- SGD 11 - https://unstats.un.org/sdgs/report/2020/goal-11/
- Collaboration, Critical Thinking, Problem Solving

Specific materials needed:

Minecraft Education version

Book & Quill

Set budget

Sustainable materials

Evaluation for teachers:

Did you students enjoy the activity?

Were the objectives met?

Would you change anything?

Evaluation for students

Did you enjoy the activity?

Were the objectives met?

References: Adjusted activity from: https://education.minecraft.net/lessons/stem-classroom

4.7. Lesson Plan / Activity 7

Title and scope of activity: Guess who [STEAM Personalities and life]

Duration:2 x45 mins - activities will be based on other lessons prior to the activity

Year Group: Any KS3 - Lower School Class

Number of participants: Maximum of 25

Gaming element:

Blooket - Digital Quiz Version

Scratch - Students create the game.

Unplugged version in class

The activity might also be a combination of all three.

Previous knowledge:

The activity is based on STEAM personalities and personalities that made an impact in Gender Equality issues the students will learn about, either through the project or through the syllabus from a variety of subjects [Arts, Music, Computing, Mathematics, Science, Languages…] All students will be given the tools to research the lives of these chosen personalities through their lessons prior to this activity

Objectives:

Art: identify and appreciate artists work and their technique

Description of activity:

Students will work in pairs. They will wear a clue on them that they will not be able to see and with the help of their partner they need to guess which personality they are. Clues can be pictures of their art, creations or an important part of their lives.

Specific materials needed:

Cards with information of the STEAM personalities. Information can include:

- Photos of their creations/inventions/art
- Short sentences about their life
- Clues about them

Digital Extension:

Use Scratch to code a prototype of the game, present the user with the facts about the person and ask them to choose the correct personality. Add points accordingly [The extension applies to Y8 and Y9]

Alternative: Use Blooket [https://www.blooket.com/] to create a quiz based on the personalities instead of Scratch and choose the Code Version to relate it to a Crypto Theme.

Evaluation sheet for teachers:

1. Was the activity easy to implement?
2. Did your students enjoy playing in the game?
3. Did they get interested?
4. Did the students remember some of the facts after the activity?

Evaluation sheet for students:

1. Did you enjoy the activity?

2. How many names of women can you recall?
3. Did the game change your opinion about the potential of women in STEAM?

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