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DIGITAL IMPROVEMENT BY GAME IN TEACHING - DIGITGAME

DATE	Place	Event scale	Event title	Event Webpage	Organization	Target num particip	Target type and sector	Pub Type	Publication Title	Link to Paper/Source
2018 June	Italy (Sesto Fiorentino)	National Exhibition	Open Lab	https://www.openlab.unifi.it/	external		general public and school			
27/11 - 01/12 2018	Mantua	International Conference	World Forum on Urban Forest	https://www.wfuf2018.com/	external	more than 1000	international reaserchers/stakeholders	article	DIGITgame: Gamification as Amazing way to learn STEM Concepts Developing Sustainable cities Idea in the Citizen of the Future	https://doi.org/10.33423/jsis.v14i4.2161
10-13 January 2019	Tokyo Japan	International Conference	IC4E 2019	http://www.ic4e.net/history/Prog-2019.pdf	external	more than 1000	international reaserchers/stakeholders	article	STEM concepts developing sustainable cities idea in the citizens of the future: the methodology of Erasmus+ project DIGITgame (Digital Improvement by Game In	doi:10.1145/3306500.3306536
11-13 march 2019	Valencia	International Conference	INTED 2019	https://iated.org/inted/	external	more than 1000	international reaserchers/stakeholders	article	DIGITgame project: communicate stem through an innovative teaching methods	doi:10.1145/3306500.3306536
6-9 July 2019	Orlando	International Conference	Education and Information Systems, Technologies and Applications: EISTA 2019©	http://www.iiis2019.org/imsci/website/default.asp?vc=5	external	more than 5000	international reaserchers/stakeholders	article	Gamification as educational strategy for STEM learning: DIGITgame project a collaborative experience between Italy and Turkey high schools around the Smartcity concept.	ISBN - Volume II: 978-1-950492-21-3

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Ibimet ISTITUTO DI BIOMETEOROLOGIA
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An amazing way to develop sustainable cities concept in the citizens of the future

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DIGITgame is a project founded by the E.U. in the framework of Erasmus+ program. The project intends to improve scientific skills and competence through more effective, innovative teaching methods. The strategy, elaborated by the project Consortium of Italian, Turkey and England partners, to reinforce learning skills is based on Smart City projecting actions by the development of a didactic minigame with challenges based on the scientific concepts acquired.

The core idea is to involve students in projecting a city "smart" , designed as a minigame-challenge, focused on main crucial elements called "smart city **assets**".
Variables constitute the "ecological framework" characterized and managed by the sustainable chooses and equilibrium on **Assets** use.
Assets and Variables are didactically referred to some basic concepts closely interlinked:
-**CO_2** and **energy** balance (green transports/solar panels/recycled stations)
-The role of **plants** in this balance
- evaluation of urban **plants growth conditions** (trees/weather/stations/climate/smart buildings/industrialization)

VARIABLES	**ASSETS** (Realized by pilot classrooms in Italy and Turkey)
Climate - Three Types: Dry and windy / Hot and humid / Humid and cold (no seasons - yearly average)	Recycle Stations (they will buy and place them once the answer some questions) – related to Smart City
Industrialization - Three Types: Low / Medium / High	Trees (10 from Italy - 10 from Turkey) (some features of assets will be set as unchangeable) – related to VOC
Level of Green: Low / Medium / High	*Weather Stations*: One basic - One more advance (students will answer questions to modify their station from basic to advance)
Green Transport: Yes or Not	Questions about green transport and cars to increase money or score
	Solar Panels (the energy that is produced increases the score. The solar panels have to be buy)
	Smart Building (elements – for a fee - to build the house to increase the score and happiness)


Public green area

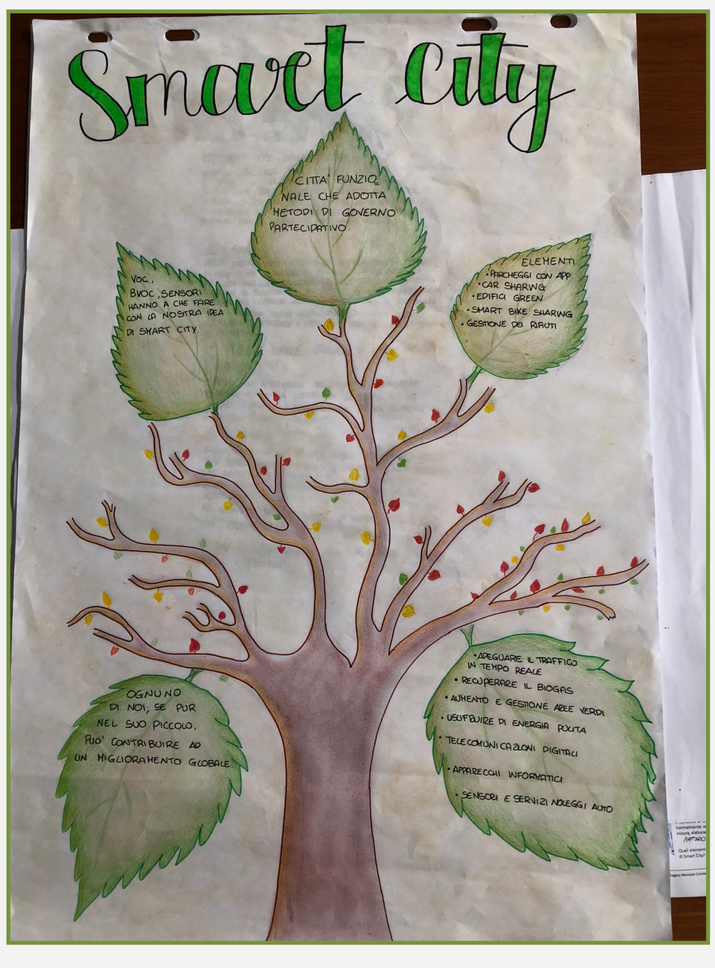

Public green area

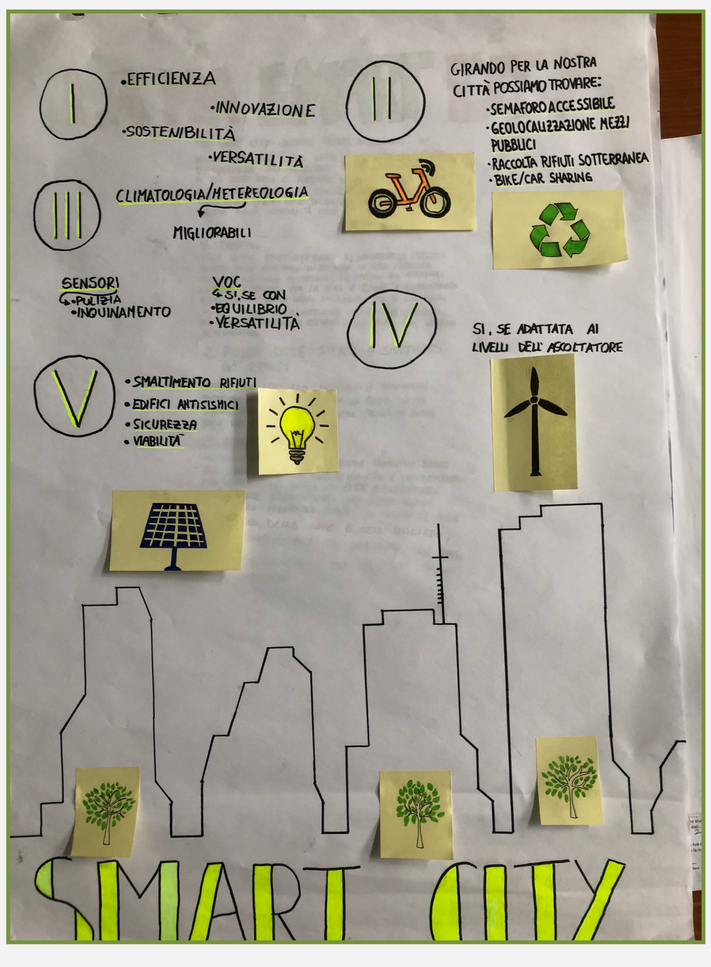

Bike facilities and infrastructures (including some software hurdles!)


Organised and fuel station Parking

The challenge is to balance economical aspects (game score and coins) and ecological level (happiness) in designing a green city. **Score**, **coin** and **happiness** values of each assets are defined by the students after **thematic frontal classes** with experts on each single game asset.

The project aim is to involve students by gamification in **deepening urban ecosystem equilibrium** and at the same time crate a **consciousness in young citizens** and future urban manager and policy makers.





Lessons were unconventional and the experts selected in a more wide E.U. Context (LIFE project MOTTLES).

Students take the core idea of the project summarizing the acquired knowledge and underlining the links between different concepts and solutions.

World Forum on Urban Forests Mantova 2018

World Forum on Urban Forests Conference
28 Novembre – 01 Dicembre 2018, Mantova (Italy)
https://www.wfuf2018.com

ABSTRACT
DIGITgame Erasmus+ project: Digital Improvement by Game In Smart City projecting. An amazing way to develop sustainable cities concept in the citizens of the future.
L.Bonora, F.Martelli, V.Marchi

Session: Day3 The Future - Topic Changing people

DIGITgame is a project founded by the E.U. in the framework of Erasmus+ program, project that intends to improve scientific skills and competence through more effective, innovative teaching methods. The strategy, elaborated by the project Consortium of Italian, Turkey and England partners, to reinforce learning skills is based on Smart City projecting actions by the development of a didactic minigame with challenges based on the scientific concepts acquired.
DIGITgame propose a new approach to communicate and teach traditional topics of environmental sciences by the use of the new thematic of Smart Cities and taking advantage introducing the videogame solution. This didactic strategy will permit to reinforce the achievement of advanced and high quality competences, both in scientific topics and digital knowledge. It is way to reinforce the consciousness on sustainable and smart cities policy and management in the citizen of the future.
The mini-game is organized around a set of "basic variables" (climate, industrialization, green level, green transports) that design the virtual city contest, the students challenge is to project and build the "assets" (urban trees, urban climate detection by weather station positioning, green transports, solar panel and recycle stations distribution, smart building) from a dare point of view, balancing costs, score, constrains and final goal. Each of the assets represents a subject of the official national school's curriculum in IT and TK and it will be the subject of in-room lessons and seminars. The match between traditional approach, gamification challenge and informatics is the keystone to turn young students in involved and aware citizens. All the project steps are driven by questionnaire that have showed us the present under involvement of young people in environment knowledge and planning and will supply the Consortium in tuning the skill in a more effective students training.

Key words: Smart City, gamification, teaching, science

An amazing way to learn STEM concepts developing sustainable cities idea in the citizens of the future: the methodology of Erasmus+ project DIGITgame (Digital Improvement by Game In Smart City projecting)

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ABSTRACT

DIGITgame intends to improve scientific skills and competence through more effective and innovative teaching methods, from January 2018 to December 2019; activities are already in progress and the present work intends to communicate the methodological approach that has been adopted by the project Consortium. The strategy to reinforce learning skills, is based on Smart City projecting actions by the development of a didactic mini-game with challenges based on the scientific concepts acquired. DIGITgame proposes a new approach to communicate and teach traditional topics of environmental sciences using the new thematic of Smart Cities and taking advantage introducing the videogame solution. This didactic strategy will permit to reinforce the achievement of advanced and high quality competences, both in scientific topics and digital knowledge. The mini-game is organized around a set of "basic variables" that design the virtual city contest, the students challenge is to project and build the "assets" from a dare point of view, balancing costs, scores, constrains and final goal. Each asset presents a subject of the official national school's curriculum in IT and TK and it will be the subject of in-room lessons and seminars. The match between traditional approach, gamification challenge and informatics is the keystone to turn young students in involved and aware citizens. All the project steps are driven by questionnaire that have showed us the present under involvement of young people in environment knowledge and planning and will supply the Consortium in tuning the skill in a more effective students training.

CCS Concepts

• Human-centered computing→Collaborative and social computing • Human-centered computing→Open source software

Keywords

1. Experimental e-education; STEM; gamification; science didactic; Smart cityINTRODUCTION

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Computers and technology have influenced the nature of the "digital native citizens" life and the most recent generation of students have grown up with these technologies. [1]

This generation is immersed in interactive, immediate and multimodal communication mediated through technology. As a result, many educational researchers have asserted that digital natives have different ways of expressing themselves and different learning preferences because of their immersion with ICT. [2], [3]

Despite our increasing technological dependence, the decline in high quality scientific vocations is inexorable. The EC studied this trend and raised concerns about it. Kier [4] stated that negative attitudes and lack of interest about Science, Engineering and Mathematic skills are two of the main problems to be addressed facing the loss interest of youth in increasing and consolidating their school knowledge. Many high school students see school science as uninteresting, unimportant and irrelevant to their lives, as a matter of rote learning fact. [5]

Regarding science education, students often fail simple questions because they hold misconceptions or use and interlink concepts incorrectly and this hinders their domain related reasoning. Research findings suggest that traditional instructional approaches like textbook based and hands-on practice often do not succeed in deep conceptual understanding.

Digital natives students have different learning styles and preferences [7] characterized by a multitasking approach, oriented to visual media; they prefer to work on activities rather than reading texts or following instruction, and are less motivated in the environments that lack technology. Because of this, it is crucial that schools and educators respond to this students' experiences in ways that are significant for education; teachers can leverage against technologies allowing students to meet demands of a future workforce in a global information society.

The DIGITgame project intends to attract young people to science studies by supplying an alternative way to use and apply basic and advanced scientific concepts in a technological tool very familiar and appealing as a videogame. The positive competition between the different "designer groups" in different school and countries will increase the use of acquired concepts to develop alternative ideas and solutions to better face the game contest.

2. METHOD: INITIAL SITUATION DEFINITION AND DIDACTIC STRATEGY DESIGNING

In this section we describe how the DIGITgame didactic approach, in facing STEM underachievement and lack of interest impact, has been documented using a pre and post testing strategy and how the cross-subject compared analysis between IT and TK science issues has been carried out as strategic teaching platform for the successive project actions.

These first results represent a mix of quantitative monitoring (questionnaires) and qualitative case study methodology.

2.1 Initial situation definition

The first steps required to determine how the general problem of the teaching STEM with innovative didactic strategies is to find a way to translate into a number the initial hypotheses concerning the student consciousness in technology for learning.

A formal standardized questionnaire is a survey instrument useful to collect data from individuals about themselves, their habits and behaviour. Based on that, the impact of DIGITgame didactic approach will be documented using a pre and post testing strategy; method popular (even if a bit controversial in literature), easy to apply and characterize by a not time-consuming application for students and teachers (low dropout rate). The method, based on targeted questionnaires, permits to check student's and teacher's changes particularly in attitudes and behaviour toward science specific subject and related learning/teaching strategies. With the pre/post-testing investigation, students and teachers are asked to share the knowledge or attitude they had toward particular aspects in approaching teaching/learning science before DIGITgame experience and after. In general when participants are asked to respond to a question about how much they are conscious about a particular behaviour, they are unconsciously more able to accurately reflect, during and after specific and aimed actions (DIGITgame activities), on the degree of change in knowledge or attitude.

Furthermore, respondents oftentimes are not aware on particular behaviours or mindset in specific daily and usual contexts. With the retrospective questionnaires respondents are given an opportunity to fell and to test how much they face considered issues by a passive attitude.

With these aims DIGITgame foresee three types of questionnaire;

- an initial set of questions to investigate the approach and behaviour, both of students and teachers, in considering and using devices (Smartphone, PC, tablet) and Internet support in investigating science subjects,

- a set of questions, shared at the end of the project operative activities, to understand the changes in devices and Internet utility awareness,

- a final questionnaire to test the effective level of appreciation and fun experienced by the project actors during the activities and in general in the project participation.

The main aim of "questionnaires actions" in DIGITgame project is to understand the impact of the activities and resources and efforts exploited. Concerning the reference methodology we decide to apply the approach proposed by Kier et al. [4] in a simplified version fitted to the project activities and deadlines.

In the project the "questionnaire activity" represented a small survey aimed to give indications related to attitudinal, habits and preferences, it isn't a systematic data collection concerning student's information across all of the STEM subject areas. This kind of survey contributes to develop measurements and investigations toward STEM context and high school students' interest in STEM

In this study, we adopt the STEM Career Interest Survey (STEM-CIS), which is a type of 5-point-Likert scale, in Turkey and Italy. The questionnaires were administrated to 113 students and 23 teachers.

A questionnaire template has been developed based on the adaptation of the ‘Research and Science Education" questionnaire.

It is realized to achieve the following results:

- ✓ Identify the knowledge on STEM
- ✓ Identify the use of smartphone to study
- ✓ Identify the level of knowledge of science topics that will be increased during the project.

The same questionnaires, with some changes, will be administrated at the end of the pilot activity to understand and compare the level of knowledge before and at the project end. The template of the questionnaire has been planned in different sections to detect different aspects. The survey results were displayed in simple descriptive statistical tables and graphs. (See chapter First results)

2.2 Didactic strategy designing

The first efforts to define the project didactic strategy has been driven by the little consciousness about the differences in school curricula between EU national institutions.

Many descriptions are available regarding the purposes of a comparative education and didactic structure analysis such as understanding our own and other countries’ educational systems; improving, developing, and reforming educational systems, policy, and practice; predicting the success and consequences of educational change; and developing tools to aid the construction of theoretical frameworks. [8]

Few studies of teaching strategy have examined the differences in teacher effectiveness are related to differences in subject matter covered, and there is still a tendency to discuss issues of teaching and learning in general terms separated from the content that has been taught.

In this framework, project Consortium carried out the TK and IT school curriculum collection and comparison in order to have the necessary indications on common subjects and issues. In collaboration with the partner schools, the age's groups and the specific strands and subject - characterizing the focus of the two STEM National School curricula - the curricula has been identified in detail and then summarized in main skill for an easier reading and comparison.

School curricula in science can be approached and analyzed in different ways; including the broad areas of knowledge (concepts) to be covered; evaluating the specific activities to be carried out; focusing learning outcomes to be achieved (the skills that have to be acquired).

The DIGITgame team strategy to meet the specific project objective has been to consider the national range of science learning and issues to merge finally in a selection of subject that will contribute to more than one learning outcome.

After this comparison activity, the team identified a core set of issues derived by the previous matching on common STEM subjects in IT and TK national school curricula. These issues have been classified in two main groups: **Variables and Assets** (Table 1). This general grouping is functional to the successive didactic work and organization. **Variables** constitute the game software structure that will be developed by the virtual world software Company; it is the general framework where students will develop the **Assets**. In fact, by the selection of climate/industrialization/green and transport levels, the game identifies the final objective: increase or maintain the Smart level of the city. It is possible by an intelligent use of the Assets in the game.

Concerning the assets these have been focused as the main STEM common elements that will be the subject of a double deepening.

1) traditional lessons: on each Asset, a specific traditional lesson has been defined and structured, by an operative worksheet; in this way it will be possible to replicate lessons in different classes. The traditional lesson is tuned to supply students detailed information concerning the Science, Technology, Engineering and Mathematic elements that we want to reinforce in their scholastic schooling.

2) videogame creation: this second didactic step will engage students in practical application related to the traditional lessons learned in the previous phase of the project. They have to build the game logic by the inclusion of Assets (recycled station, tree, green transport etc.) in the game developments.

For each asset score, costs, pro and cons have to be defined with the aims to built our City (defined by the Variable selection) as Smart as possible.

The innovative didactic idea is to involve students in build and tuning the videogame logic by making use of the scientific knowledge acquired in the point 1.

Table. 1 Variables and Assets

VARIABLES	ASSETS (Realized by pilot classrooms in Italy and Turkey)
Climate - Three Types: Dry and windy / Hot and humid / Humid and cold (no seasons - yearly average)	Recycle Stations (they will buy and place them once the answer some questions) – related to Smart City
Industrialization - Three Types: Low / Medium / High	Trees (10 from Italy - 10 from Turkey) (some features of assets will be set as unchangeable) – related to VOC
Level of Green: Low / Medium / High	*Weather Stations*: One basic - One more advance (students will answer questions to modify their station from basic to advance)
Green Transport: Yes or Not	Questions about green transport and cars to increase money or score
	Solar Panels (the energy that is produced increases the score. The solar panels have to be buy)
	Smart Building (elements – for a fee - to build the house to increase the score and happiness)

3. FIRST RESULTS

The Initial situation definition survey results are here displayed in simple descriptive statistical tables and graphs.

In the first part of the questionnaire, same general information about young students will be collected, such as age, gender, school.

In Figure 1 the results about gender from Italian and Turkish schools. We immediately see a balanced percentage between males (58%) and females (42%) who completed the questionnaire.

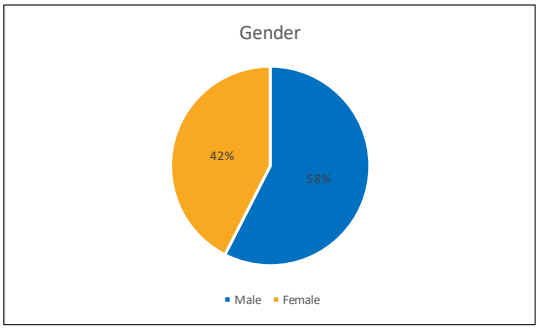

Figure 1. Gender distribution

The second section of the questionnaire detects the knowledge on skills in relation to Science, Technology, Engineering and Mathematics (15 questions). Data were collected through a Likert-type test scheme [9] based on a five-value scale: 1=strongly disagree; 2=disagree; 3= neither agree nor disagree; 4=agree; 5=strongly agree.

The following figures (2,3,4 and 5) show the results related to the level of knowledge and interaction with the STEM subjects. Students were involved to answer questions about some aspects on STEM with refers on the subject class, homework, future career and the importance of new technology to improve and deepen topics treated at school. The aim of this section is to detect the different vision on STEM skills and use of smartphone/ICT from students.

The results underline that males and females have given answers fairly balanced for all items. The main item with a marked different score from male and female is related to the question 'I use the smartphone/pc to increase topics treated at school'. The highest score was given by males.

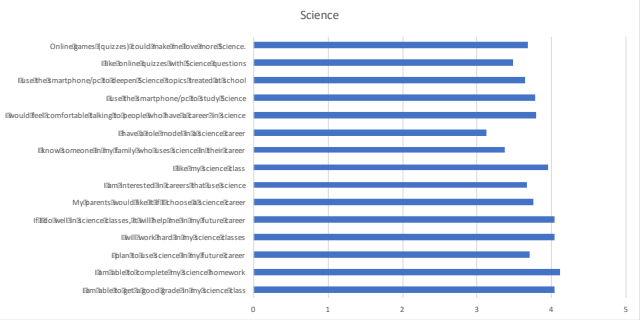

Figure 2. Science skills

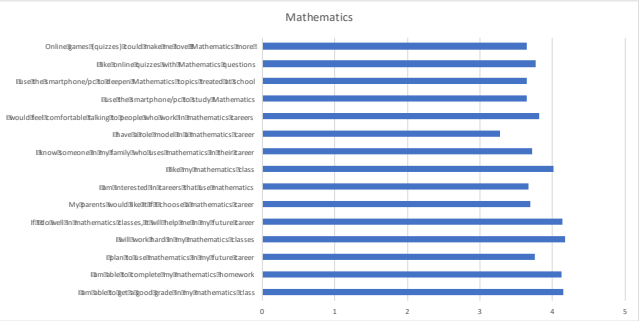

Figure 3. Mathematic skills

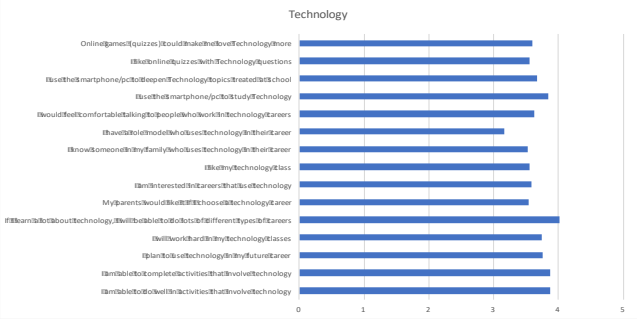

Figure 4. Technology skills

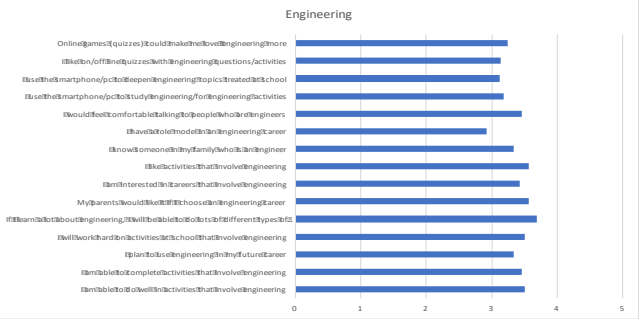

Figure 5. Engineering skills

The results show a different scene in the different skills treated. The data underline a lower level of knowledge and interaction in Engineering and Technology compared to Mathematics and Science. Students' answer highlight also a lower level of score related to the question 'I have a role model in an engineering/technology/mathematics/science career' than the other questions proposed.

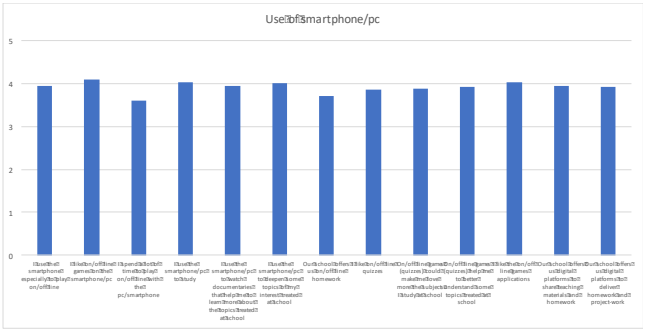

Figure 6. Use of Smartphone and PC

Another part of the questionnaire detects the students likely in using smart technologies to learn and to deepen school subjects (Figure 6). The results show a constant trend about a use of smartphone/pc. The two questions with a slightly lower score are 'I spend a lot of time to play on/off line with the pc/smartphone' and 'Our school offers us on/off line homework'

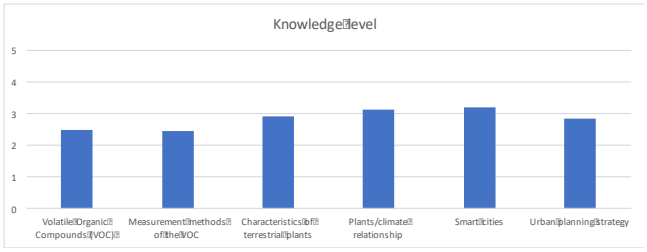

Figure 7. Knowledge level

The last section of the questionnaire is designed to identify the knowledge level of STEM materials that will be treated in the framework of the DIGITgame project. The figure 7 shows a level of knowledge less than '4 - good' for all items. In particular, the figure highlights a lower score of knowledge level of 'VOC-Volatile Organic Compounds' and 'Measurement of the VOC'.

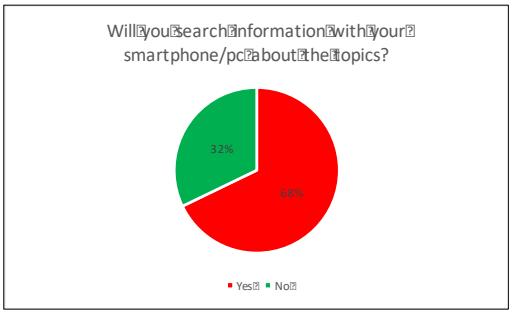

Figure 8. Searching information by smartphone/pc about the STEM topics

The section of the questionnaire that detected the level of knowledge of STEM underlines that more than 50% of students will search information about the topics that will be treated during DIGITgame project. The main topics that the students will be looking for are VOC and Smart Cities (Figure 8).

This first survey, that will be continued during the DIGITgame project life, underlines that technology-supported didactic models as gaming, virtual laboratories, international collaborative projects, real-time formative assessment and skills-based assessment, have the potential to improve students' learning outcomes, including

development of higher-order thinking skills, and to expand the range of learning opportunities made available to students. [3]

CONCLUSIONS

In the presented research the respondents are students from 14 to 16 ages in Italy and Turkey. The schools are involved in the DIGITgame project in two different pilot activities: at the beginning of the project as developers of the videogame to increase their STEM knowledge and at the end of the development phase in order to support the other implementers schools involved to test and to improve the videogame.

The questionnaire was carried out before the beginning of the first pilot activity with the aim to collect information about the level of knowledge of STEM topics and the use of technology at school. The same questionnaire will be administrated at the same sample of students in order to understand and compare the level of knowledge at the end of the pilot activity (lessons and development of videogame).

The results of this first step of project show an interest and attitudes toward science and mathematics by the project students. While the results of the other skills analysed, engineering and technology, show a different framework. The score assigned to each question is lower than science and mathematics. In the Italian and Turkish schools the subject of engineering and technology are in the scholastic curriculum, but at the same time they are not specify as subject in the schools' hours. Otherwise mathematics and science are subjects itemise in the schools' hours. The lower score assigned to engineering and mathematics could be related to this aspects and students do not perceive they as specific subjects, despite being treated during school lessons.

The results are interesting and can be used in future research with integrated data collected also from other stakeholders, such as teachers, in order to compare the some topics and understand the opinion of teachers in relation to students' skills.

DIGITgame project can represent a model to reinforce the learning of STEM concepts by technology applications for different target students. The objective of interest increasing is to promote student attitudes toward careers in science, technology, engineering, and mathematics.

Moreover, the work methodology taken by the Project team show the possibility of collaboration and support in an international framework, for promoting educational innovation.

4. ACKNOWLEDGEMENT

DIGITgame project is carrying out with the project partners in the framework of Erasmus+ Programme 2017-1-IT02-KA201-026822.

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DIGITGAME PROJECT: COMMUNICATE STEM THROUGH AN INNOVATIVE TEACHING METHODS

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Computers and technology have influenced the nature of the "digital native citizens" life and the most recent generation of students have grown up with these technologies (Wang et al. 2014). Despite our increasing technological dependence, the decline in high quality scientific vocations is current. Kier (2014) stated that negative attitudes and lack of interest about Science, Engineering and Mathematic skills are two of the main problems to be addressed facing the loss interest of youth in increasing and consolidating their school knowledge. The need to propose new approach and innovative teaching methods is increasingly present. In the framework of ERASMUS+ Programme has been developed and financed DIGITgame project. DIGITgame “Digital Improvement by Game In Teaching” is aimed to improve scientific skills and competence through more effective and innovative teaching methods.

DIGITgame proposes a new approach to communicate and teach traditional topics of environmental sciences using the new thematic of Smart Cities and taking advantage introducing the videogame solution. This didactic strategy will permit to reinforce the achievement of advanced and high quality competences, both in scientific topics and digital knowledge. It is the way to reinforce the consciousness on sustainable and smart cities policy and management in the citizen of the future. The mini-game that will develop during the project is organized around a set of "basic variables" (climate, industrialization, green level, green transports) that design the virtual city contest, the students challenge is to project and build the "assets" (urban trees, urban climate detection by weather station positioning, green transports, solar panel and recycle stations distribution, smart building) from a dare point of view, balancing costs, scores, constrains and final goal.

A preliminary research was conducted on measuring STEM knowledge and how ICT (Information and Communication Technology) are used to study and deepen the topics treated at school.

The instrument of the research was a survey developed according to approach proposed by Kier et al. (2014), suggested in a revised version with additional questions to students and also teachers regarding the use of ICT to deepen STEM subject. The survey was carried out in the schools involved in the project, Italy and Turkey in March 2017. The survey is administrated at students (from 12 to 17 years) and to their teachers with the aim to know their perception on the knowledge of skills and the use of devices (smartphone, PC, tablet) to study and deepen STEM subjects treated at school.

The questionnaires were carried out to 113 students and 23 teachers. The results of the study will be integrated with others data collected at the end of the project at the same students and teachers, in order to have a framework related to the knowledge on STEM subject.

keywords: gamification, ict, stem, smart city, teachers and students’ perceptions.

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DIGITgame is a project founded by the E.U. in the framework of Erasmus+ program, axis KA2 'Cooperation for Innovation and the Exchange of Good Practices' and objective 'KA201 - Strategic Partnerships for school education'. It intends to improve scientific skills and competences through more effective and innovative teaching methods.

The project, started in 2018 January, will be closed in 2019 December; the activities are already in progress and the present work intends to communicate the methodological approach that has been adopted by the project Consortium. The strategy, elaborated by the Italian, Turkey and English partners to reinforce learning skills, is based on Smart City projecting actions by the development of a didactic mini-game with challenges based on the scientific concepts acquired. DIGITgame proposes a new approach to communicate and teach traditional topics of environmental sciences using the new thematic of Smart Cities and taking advantage introducing the videogame solution. The strength to involve actively students and teachers is a double "use" of the concept of [illegible] to project a game is an unusual amazing didactic activity (entertainment) who's final result is a game designed to support STEM education in an entertainment perspective.

This didactic strategy will permit to reinforce the achievement of advanced and high quality competences, both in scientific topics and digital knowledge. It is the way to reinforce the consciousness on sustainable and smart cities policy and management in the citizen of the future. The mini-game is organized around a set of "basic variables" (climate, industrialization, green level, green transports) that design the virtual city contest, the students challenge is to project and build the "assets" (urban trees, urban climate detection by weather station positioning, green transports, solar panel and recycle stations distribution, smart building) from a dared point of view, balancing costs, scores, constrains and final goal. Each asset represents a subject of the official national school's curriculum in IT and TK and it will be the subject of in-room lessons and seminars. The match between traditional approach, gamification challenge and informatics is the keystone to turn young students in involved and aware citizens. All the project steps are driven by questionnaires that have showed us the present under involvement of young people in environment knowledge and planning and will supply the Consortium in tuning the skills in a more effective students training.

[illegible]: Experimental edutainment; gamification; STEM didactic; Smart city

[illegible]

Computers and technology have influenced the nature of the "digital native citizens" life and the most recent generation of students has grown up with these technologies. [1]

This generation is immersed in interactive, immediate and multimodal communication mediated through technology. As a result, many educational researchers have asserted that digital natives have different ways of expressing themselves and different learning preferences because of their immersion with ICT. [2], [3]

Despite our increasing technological dependence, the decline in high quality scientific vocations is inexorable. The EC studied this trend and raised concerns about it. Kier [4] stated that negative attitudes and lack of interest about Science, Engineering and Mathematic skills are two of the main problems to be addressed facing the loss interest of youth in increasing and consolidating their school knowledge. Many high school students see school science as uninteresting, unimportant and irrelevant to their lives, as a matter of rote learning fact. [5,6]

Regarding science education, students often fail simple questions because they hold misconceptions or use and interlink

concepts incorrectly and this hinders their domain related reasoning. Research findings suggest that traditional instructional approaches like textbook based and hands-on practice often do not succeed in deep conceptual understanding.

Digital natives students have different learning styles and preferences [7] characterized by a multitasking approach, oriented to visual media; they prefer to work on activities rather than reading texts or following instruction, and are less motivated in the environments that lack technology. Because of this, it is crucial that schools and educators respond to this students' experiences in ways that are significant for education; teachers can leverage against technologies allowing students to meet demands of a future workforce in a global information society.

The DIGITgame project intends to attract young people to science studies by supplying an alternative way to use and apply basic and advanced scientific concepts in a technological tool very familiar and appealing as a videogame. The positive competition between the different "designer groups" in different schools and countries will increase the use of acquired concepts to develop alternative ideas and solutions to better face the game contest.

In the presented research the respondents are students from 14 to 16 ages in Italy and Turkey. The schools are involved in the DIGITgame project in two different pilot activities: at the beginning of the project as developers of the videogame to increase their STEM knowledge and at the end of the development phase in order to support the other implementers schools involved to test and to improve the videogame.

The questionnaire was carried out before the beginning of the first pilot activity with the aim to collect information about the level of knowledge of STEM topics and the use of technology at school. The same questionnaire will be administrated at the same sample of students in order to understand and compare the level of knowledge at the end of the pilot activity (lessons and development of videogame).

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In this section we describe how the DIGITgame didactic approach, in facing STEM underachievement and lack of interest impact, has been documented using a pre and post testing strategy and how the cross-subject compared analysis between IT and TK science issues has been carried out as strategic teaching platform for the successive project actions.

These first results represent a mix of quantitative monitoring (questionnaires) and qualitative case study methodology.

d

The first steps required to determine how the general problem of the teaching STEM with innovative didactic strategies is to find a way to translate into a number the initial hypotheses concerning the student consciousness in technology for learning.

A formal standardized questionnaire is a survey instrument useful to collect data from individuals about themselves, their habits and behaviour. Based on that, the impact of DIGITgame didactic approach will be documented using a pre and post testing strategy; method popular (even if a bit controversial in literature), easy to apply and characterize by a not time-consuming application for students and teachers (low dropout rate). The method, based on targeted questionnaires, permits to check student's and teacher's changes particularly in attitudes and behaviour toward science specific subject and related learning/teaching strategies. With the pre/post-testing investigation, students and teachers are asked to share the knowledge or attitude they had toward particular aspects in approaching teaching/learning science before DIGITgame experience and after. In general when participants are asked to respond to a question about how much they are conscious about a particular behaviour, they are unconsciously more able to accurately reflect, during and after specific and aimed actions (DIGITgame activities), on the degree of change in knowledge or attitude.

Furthermore, respondents oftentimes are not aware on particular behaviours or mindset in specific daily and usual contexts. With the retrospective questionnaires respondents are given an opportunity to fell and to test how much they face considered issues by a passive attitude.

With these aims DIGITgame foresees three types of questionnaires:

- an initial set of questions to investigate the approach and behaviour, both of students and teachers, in considering and using devices (Smartphone, PC, tablet) and Internet support in investigating science subjects,

- a set of questions, shared at the end of the project operative activities, to understand the changes in devices and Internet utility awareness,

- a final questionnaire to test the effective level of appreciation and fun experienced by the project actors during the activities and in general in the project participation.

The main aim of "questionnaires actions" in DIGITgame project is to understand the impact of the activities and resources and efforts exploited. The research instrument was a survey developed according to Kier et al. [4] approach, applied in a revised version with additional questions to students and teachers; questions regarding the use of ICT to deepen STEM subjects. The students' questionnaire is different articulated than the teachers' survey and its aim is to understand the level of knowledge and the use of smartphone/pc to study the STEM subjects. The aim of teachers' questions is to understand their opinion in relation to students' skills and use of smartphone about STEM topics. In each survey, there are equal questions in order to compare the answers provided by students and their teachers.

In the project the "questionnaire activity" represents a small survey aimed to give indications related to attitudinal, habits and preferences, it isn't a systematic data collection concerning student's information across all of the STEM subject areas. This kind of survey contributes to develop measurements and investigations toward STEM context and high school students' interest in STEM

In this study, we adopt the STEM Career Interest Survey (STEM-CIS), which is a type of 5-point-Likert scale, in Turkey and Italy. The questionnaires were administrated to 113 students and 23 teachers.

A questionnaire template has been developed based on the adaptation of the 'Research and Science Education" questionnaire.

It is realized to achieve the following results:

- ✓ Identify the knowledge on STEM
- ✓ Identify the use of smartphone to study
- ✓ Identify the level of knowledge of science topics that will be increased during the project.

The same questionnaires, with some changes, will be administrated at the end of the pilot activity to understand and compare the level of knowledge before and at the project end. The template of the questionnaire has been planned in different sections to detect different aspects. The survey results were displayed in simple descriptive statistical tables and graphs. (See chapter First results)

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The process of entertaining and at the same timeteaching, foresees the use of supports (i.e. television programs, software) that lights the curiosity and get and maintain attention.

For a very effective edutainment process, the involved actors have to collaborate noticing and supporting process itself. For this the first efforts to define the project didactic strategy have been driven by the little consciousness about the differences in school curricula between EU national institutions. [8]

Many descriptions are available regarding the purposes of a comparative education and didactic structure analysis such as understanding our own and other countries' educational systems; improving, developing, and reforming educational systems, policy, and practice; predicting the success and consequences of educational change; and developing tools to aid the construction of theoretical frameworks. [10]

Few studies of teaching strategy have examined the differences in teaching effectiveness and related differences in subjects covered, and there is still a tendency to discuss issues of teaching and learning in general terms separated from the content that has been taught.

In this framework, project Consortium carried out the TK and IT schools' curricula collection and comparison in order to have the necessary indications on common subjects and issues. In collaboration with the partner schools, the age's groups and the specific strands and subjects - characterizing the focus of the two STEM National School curricula - the curricula have been identified in detail and then summarized in main skills for an easier reading and comparison.

School curricula in science can be approached and analyzed in different ways; including the broad areas of knowledge (concepts) to be covered; evaluating the specific activities to be carried out; focusing learning outcomes to be achieved (the skills that have to be acquired).

The DIGITgame team strategy to meet the specific project objective, has been to consider the national range of science learning and issues to merge finally in a selection of subjects that will contribute to more than one learning outcome.

After this comparison activity, the team identified a core set of issues derived by the previous matching on common STEM subjects in IT and TK national school curricula. These issues have been classified in two main groups: Variables and Assets (Tab.1). This general grouping is functional to the successive didactic work and organization. Variables constitute the game software structure that will be developed by the virtual world software Company; it is the general framework where students will develop the Assets. In fact, by the selection of climate/industrialization/green and transport levels, the game identifies the final objective: increase or maintain the Smart level of the city. It is possible by an intelligent use of the Assets in the game.

Concerning the assets these have been focused as the main STEM common elements that will be the subject of a double deepening.

1) in-room lessons: on each Asset, a specific traditional lesson has been defined and structured, by an operative worksheet; in this way it will be possible to replicate lessons in different classes. The in-room lesson is tuned to supply students detailed information concerning the Science, Technology, Engineering and Mathematic elements that we want to reinforce in their scholastic schooling.

2) videogame creation: this second didactic step will engage students in practical application related to the traditional lessons learned in the previous phase of the project. They have to build the game logic by the inclusion of Assets (recycled station, tree, green transport etc.) in the game development.

For each asset score, costs, pro and cons have to be defined with the aims to built our City (defined by the Variable selection) as Smart as possible.

The innovative didactic idea is to involve students in build and tuning the videogame logic by making use of the scientific knowledge acquired in the point 1.

Table. 1 Variables and Assets

VARIABLES	ASSETS (Realized by pilot classrooms in Italy and Turkey)
Climate - Three Types: Dry and windy / Hot and humid / Humid and cold (no seasons - yearly average)	Recycle Stations (they will buy and place them once the answer some questions) – related to Smart City
Industrialization - Three Types: Low / Medium / High	Trees (10 from Italy - 10 from Turkey) (some features of assets will be set as unchangeable) – related to VOC
Level of Green: Low / Medium / High	Weather Stations: One basic - One more advance (students will answer questions to modify their station from basic to advance)
Green Transport: Yes or Not	Questions about green transport and cars to increase money or score
	Solar Panels (the energy that is produced increases the score. The solar panels have to be buy)
	Smart Building (elements – for a fee - to build the house to increase the score and happiness)

[illegible]

[illegible] and [illegible] [illegible]

The present section is focused on the results comparison between teachers and students questionnaires in Italy and Turkey. The aim of this analysis is to compare and understand the opinion of teachers in relation to students' skills and use of smartphone about STEM subjects.

Data analyses were carried out by all countries both for students (113) and teachers (23). Furthermore, analyses were also carried out on the total sample. Regarding the procedure for data analysis, the total scores and the means for each item were calculated in relation to the same questions for students and teachers.

The first part of the questionnaire is designed to detect about general information of professors and students, such as gender and teaching subject. Regarding the 23 teachers, 6 were males (26%) and 17 females (74%). The involved sample teaches mathematics, science and technology. While regarding the 113 students, 65 are males (58%) and 48 females (42%).

The second section of the questionnaire detects the students' knowledge on skills in relation to STEM (15 questions). At the same time the questionnaire for teachers is focused on the opinion of professors in relation to the students use of smarthphone/pc to deepen and study STEM topics (5 items). Data were collected through a Likert-type test scheme [10] based on a five-value scale: 1=strongly disagree; 2=disagree; 3= neither agree nor disagree; 4=agree; 5=strongly agree.

The students' results underline that males and females have given answers fairly balanced for all items. The main item with a marked different score from male and female is related to the question 'I use the smartphone/pc to increase topics treated at school'. The highest score was given by males for all STEM subjects. Students underline an interest and attitudes toward science and mathematics. While the results of the other skills analyzed, engineering and technology show a different framework. The score assigned to each question is lower than science and mathematics. In the Italian and Turkish schools the subject of engineering and technology are in the scholastic curriculum, but at the same time they are not specify as subject in the schools' hours. Otherwise mathematics and science are subjects itemized in the schools' hours. The lower score assigned to engineering and technologycould be related to that aspects and students do not perceive they as specific subjects, despite being treated during school lessons.
The results of the comparison analysis between students and teachers' questions highlight interesting data. The analysis is focused on three questions proposed to students and teachers in relation on the vision on STEM skills and use of smartphone/pc to study STEM subjects.

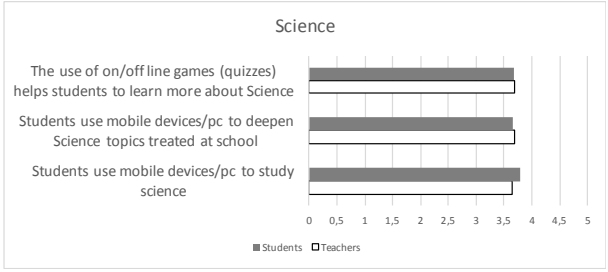

Figure 1. Students and teachers' opinion on Science

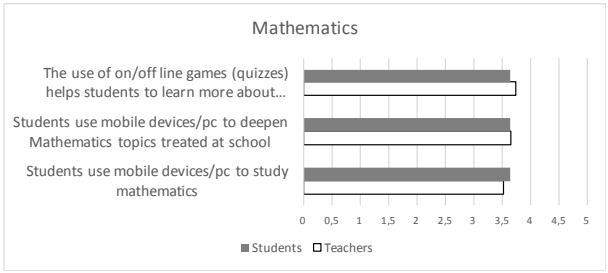

Figure 2. Students and teachers opinion on Mathematics

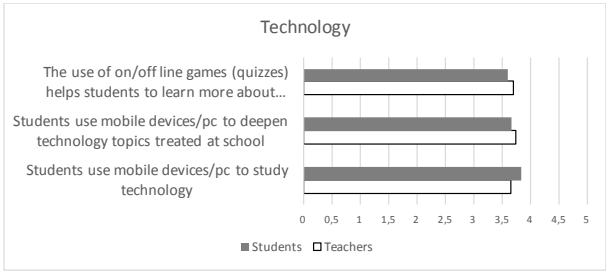

Figure 3. Students and teachers opinion on Technology

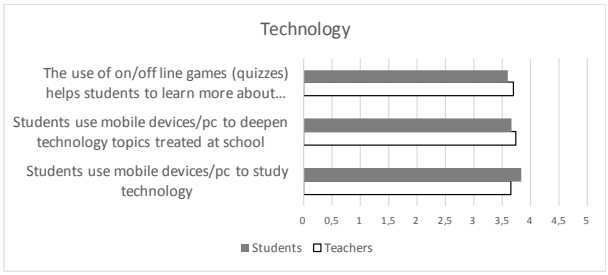

Figure 4. Students and teachers opinion on Engineering

The results show a balanced average between students and professors in relation to Science, Mathematics and Technology questions (figures 1-2-3). The question 'Students use mobile devices/pc to study science-mathematics-technology' underlines a different score. Students attribute a greater value to this question, emphasizing that they use the computer/device to study these subjects more than the teachers think. The engineering subject (figure 4) shows a different framework with different score between students and professors. The professors attribute a score greater than 3.5 (on a 5 point scale), while the average of students is just over 3 for all three questions. The results point out that students use fewer computers and smartphones to deepen topics treated at school and study engineering than other subjects (science, mathematics and technology).

Another part of the questionnaire focused the opinion about the use of school's platforms to share teaching material and homework to students (2 items). Students and teachers were asked to indicate the results on a five points scale (1=strongly disagree; 2=disagree; 3= neither agree nor disagree; 4=agree; 5=strongly agree). The results (Figure 5) show a different score between professors and students. Students attribute a higher

score than teachers for both questions (students: score of 3.9 for both questions; teachers: respectively 3.4 and 3.2).

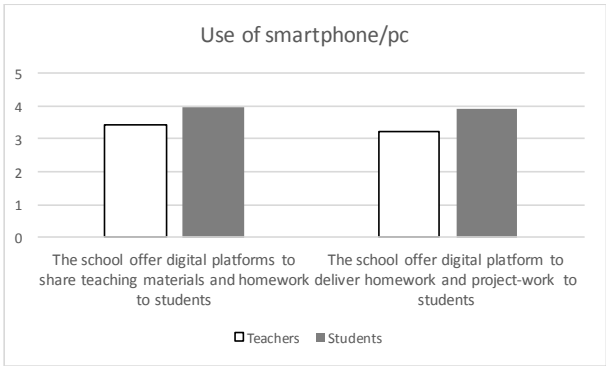

Figure 5. Students and teachers' opinion on use of smartphone/pc

The last section of the questionnaire is designed to identify the knowledge level of STEM subjects that will be treated in the framework of DIGITgame project (6 items). Students and teachers were asked to indicate the results on a five points scale (1=strongly disagree; 2=disagree; 3= neither agree nor disagree; 4=agree; 5=strongly agree). The figure 6 shows a different score of knowledge between teachers and students. The professors (score less than 3) attribute a lower score than students. The figure highlights a lower score of knowledge level of 'VOC-Volatile Organic Compounds' and 'Measurement of the VOC' confirmed by students and teachers.

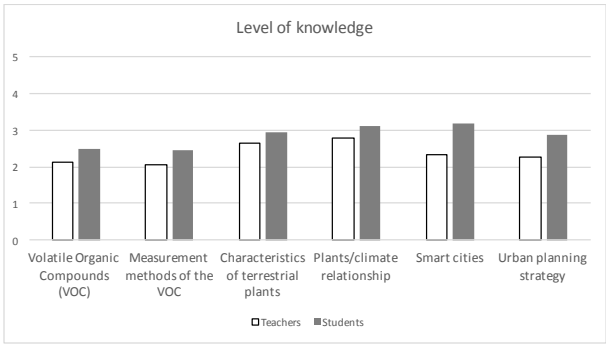

Figure 6. Students and teachers' opinion on level of knowledge

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To identify the boundary line between entertainment education and use of entertainments features for education isn't easy because the play itself contains education and entertainment elements. In the edutainment activities, players have a different role than during the simply entertainment, in fact they are conscious of the sense of the rules and support the aim to participate in edutainment experience. [8]Using as leverage this participative approach, the didactic strategy of this project has been structured with the goal to define a common standard (curricula comparison and variables/assets definition) from which to change the teacher's and student's role. Students and teachers during the in-room lessons have shown a high level of interest and involvement derived from the awareness of the successive role of "gamifiers"; lessons was longer than the usual time but final questions, comments and discussions confirmed the real attention and their related efficacy. The successive minigame implementation phase taken busy students and teachers in defining game score, coin and assets value experiencing the double role of edutainment beneficiaries (minigame platform development is itself an entertainment features) and edutainment "developers". During this experience, the motivation is changed from the external - I have learn something-, into personal - I want to know deeply something to share it in a game strategy; moreover this unexpected reversal of roles is aimed to develop an educational experience for other students. It constitutes a very strong motivation for young people. In this way the didactic game is not perceived by students as a process of teaching/learning dynamic but as a shared educational strategy able to face their needs: they spontaneously and instinctively embracedthis challenging idea.
This operative application of edutainment promoted active learning by merging educational contents and entertainment activities increasing engagement, emotion and motivation [11].To confirm and "measure" these progresses in learning actions, at the end of in-room lessons, students were asked to elaborate a final presentation, which was formally presented to the other students and teachers; diverse mix of students and different background levels shown different perspective on possible adjustments on this mix in traditional-entertainment thrust.
Moreover, the project foresees a second step of questionnaires, exactly like the first sample to perform an analytical comparison concerning the increased students and teachers awareness and involvement in the entertainment dynamics and strategies.
The aim is to tuning this double-role environment approachfor appropriate future directions.

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The results emerged from this first phase of the project are interesting and can be used in future research with integrated data collected. The aim of this first step was to understand the level of knowledge of students and the relation between the opinion of teachers and their students. In the second phase of the project the same questionnaires will be administrated to other schools in Italy and Turkey. The aim of this activity will be related to integrate data and analyze the STEM subject and the use of smartphone/pc in order to improve the minigame developed during DIGITgame project.

The results of this activity show important aspects underlined in the previous section of the study. In section related to the level of knowledge of STEM students highlights that more than 50% of students will search information about the topics that will be treated during DIGITgame project. The main topics that the students will be looking for are VOC and Smart Cities.

The first conclusions about the didactic approach confirm that the operative user interaction and edutainment was new to students; however they showed enthusiasm for this approach showing involvement both in the traditional and edutainment teaching steps. The interdisciplinary solution to face assets, helps bringing different perspective on defining approach and ideas. We believe that success of the project will supply different perspective, approaches and new ideas to edutainment and user interaction.

DIGITgame project can represent a model to reinforce the learning of STEM concepts by technology applications for different target students. The objective of interest increasing is to promote student attitudes toward careers in science, technology, engineering, and mathematics.

Moreover, the work methodology taken by the Project team show the possibility of collaboration and support in an international framework, for promoting educational innovation.

ACKNOWLEDGEMENT

DIGITgame project is carrying out with the project partners in the framework of Erasmus+ Programme 2017-1-IT02-KA201-026822.

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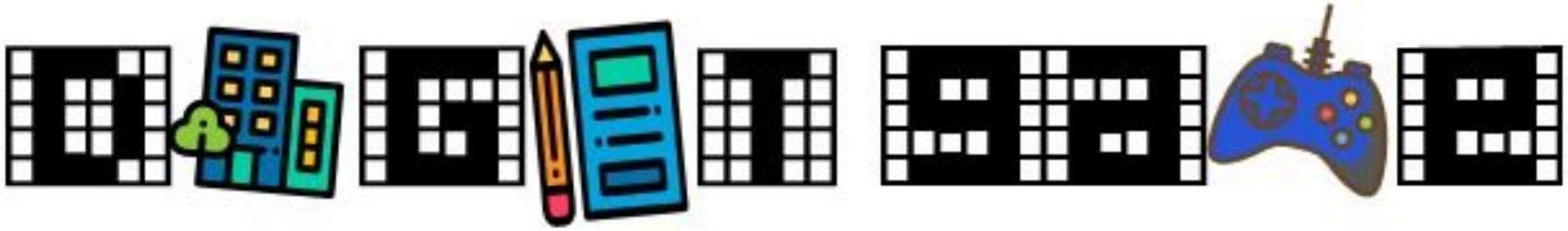


DIGITgame

Digital Improvement by Game in Teaching

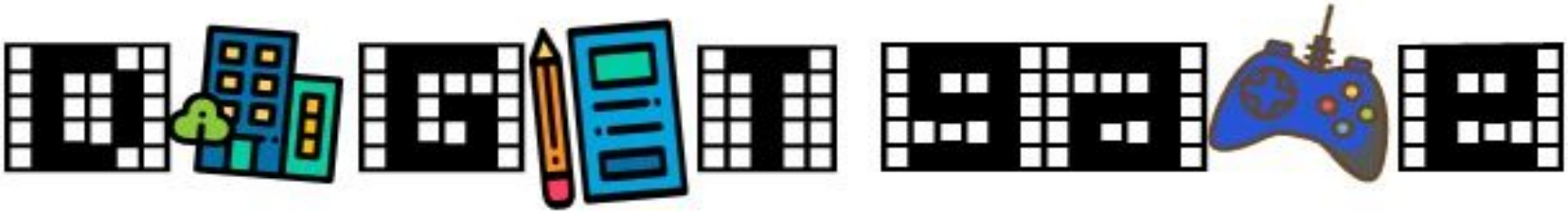
Aslıhan Kağnıcı

WSEC 2018 Istanbul

10 Haziran 2018

TAGES

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



Programe: Erasmus +

Key Action: Cooperation for innovation and exchange of good practices

Action Type: Strategic Partnerships for school education

Start: December 2017

End: December 2018

EU Grant: 229.930,00 EUR

Partners: IBIMET-CNR, TAGES, Foundation K12, Clicks&Links, Liceo Sensale


Lack of interest in STEM careers
Decline in high quality scientific vocations
Traditional instructional approaches
Lack of knowledge about how to use STEM skills

Objectives

- to achieve learning goals in science, math, technology and engineering (STEM) curriculum
- to gain 21st century skills of young students through the playful video games in smart city concept
- to make them more creative, innovative, competent and enthusiastic students on science.

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

Target Group

The main target groups of the project's activities and results are **Educators, Teachers, Students (14-17)** and **Learners communities**, in formal (schools) and informal (education foundations, research scientific institutions) learning scenarios.

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

How DIGITgame Works

Analyzes the attitudes and skills around science and ecology of educators and students

Designs and develops lessons on basic science subjects: climate dynamics, changes and evolutions; plants physiology and ecological role

Engages students (driven by their teachers) in designing, developing and playing videogames

Shares the attractive and motivating learning strategy and the best practices on high quality skills improvement

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

Project Consortium

DIGITgame Project Partners at the Kick-off Meeting in Manchester, Jan 16, 2018

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

Project Consortium

- **IBIMET-CNR (IT),** the Project Coordinator, R&D entity, engaged in a lot of projects on activities of scientific and educational programs directed to/for adults and students, able to provide knowledge and expertise on climate, meteorology and their connection to the environment
- **TAGES (TR),** an SME leader in preparing and coordinating R&D and innovation projects with a strong ICT curriculum in managing activities related with Smart Cities concepts
- **CLICKS&LINKS (UK)**, a company specialized in didactic visualisation and gamification including the creation of virtual worlds and VR applications
- **Foundation K12 (TR),** an innovative foundation expert in developing and using learning tools, resources and on-line collaborative platforms for students and teachers, able to learn, teach and co-create contents for STEM courses
- **SENSALE (IT),** a high school science-based represents the perfect context to develop-with, apply and test the methodologies and strategies core of gamification in Smart City concept deepening.

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

Activities

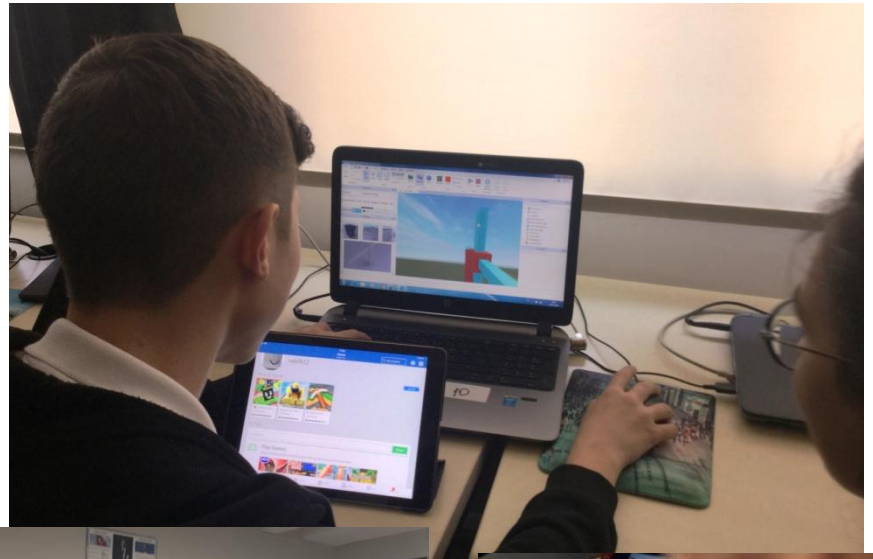
Two pilot schools in Turkey and Italy

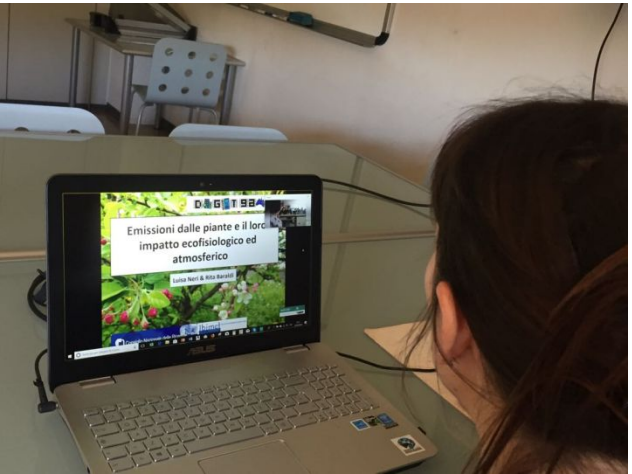
- Students' and teachers' attitude questionnaire (before & after)
  - **Identify the knowledge on STEM**
  - **Identify the use of smartphone to study**
  - **Identify the level of knowledge of science topics that will be increased during the project**
- 113 students, 23 teachers
- Type of 5-point-Likert scale

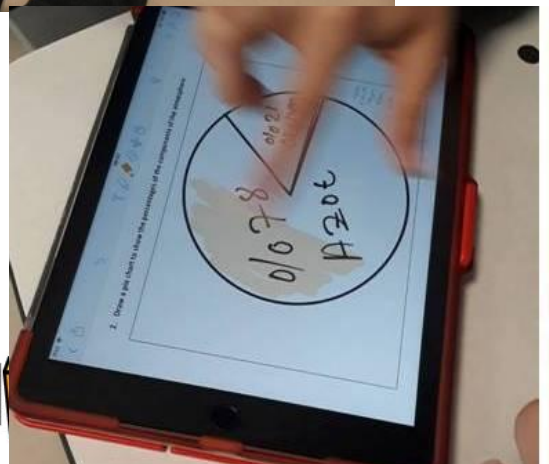
https://digitgameproject.wixsite.com/digitgame

Activities

- DIGITgame lessons designed and workshops organized in pilot schools







Activities

Air compostion

Air pollution

Climate and Plant Intreraction

Renewable Energy

Photovoltaic Energy

Urban Pollution

Sensors and Weather Station Tools

3R Waste Collection

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Next Activities

- Developing and Playing Video Games
- Video Game Competition in Turkey and Italy
- Final Conference and Award Ceremony in Itay

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Project Outputs

What is for you in the DIGITgame?

- **Pedagogical material:** Methodology for cross – subject teaching of environment education using Smart city concept to think and support the development of science, math and ICT skills
- **STEMgame Video Game platform:** The proposed p… intends to enhance the student's ability to le… ecological skills by an intense and enjo… the engagement in video game pr… tool to share, we promote an a… defined goal.
- **Toolkit for Players:** Kit with all th… oject and related competition storytelli…
- **Methodology for Exchange innova… …es:** Assessment methodology and materials for shari… practices or learning new skills within a network

Open and accessible everyone!

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Stay Tuned

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- **Instagram:** @DIGITgameSTEM
- **Twitter:** @DIGITgameSTEM #DIGITgameSTEM
- **Webiste:** https://digitgameproject.wixsite.com/digitgame

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