DIS-CODE - Disconnected, discouraged, disenabled? Let's code!

TRAINING PLAN

Number of Activity: IO1A2

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…		…
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EXECUTIVE SUMMARY

The DIS-CODE project aims to train students at drop out risk on improving digital skills and learning maths by studying coding, the 21st century language developing transversal skills such as abstract and analytical thinking, logic and problem solving and by practicing digital literacy activities such as digital storytelling, audio editing and use of the cloud as shared cognitive workspace.

The present document is the *Training Plan*: it is the Activity 2 of Intellectual Output 1, the *Training course development*.

The aim of this document is to explain the training plan which should be the guide for teachers to teach their students about Improving Digital Skills and Numerical skills using code.

The training plan includes first the training structure, where teachers can find the description and the main aim of the training, the learning objectives of the course, the methodology we recommend them to adopt, the way we have planned to organize the training modules, the target group and pre-requirements for trainees, the scientific area of the course and its duration.

After the structure, we go further each module, with a syllabus, learning objectives, methods to be used, activities and bibliography, explaining more what each module will talk about. For each module we detail some lesson plans suggesting tools, activities, methods, games, work plan and assessment which can be used by teachers with their students inside their classrooms.

SUMMARY

GLOSSARY

Coding. The process of designing, writing, testing, debugging / troubleshooting, and maintaining the source code of computer programs.

Computational thinking. Computational thinking is the thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can effectively be carried out by an information-processing agent. It is ultimately, a problem solving method that applies computer science techniques.

Digital literacy. Set of competencies required for full participation in a knowledge society. It includes knowledge, skills, and behaviors involving the effective use of digital devices such as smartphones, tablets, laptops and desktop PCs for purposes of communication, expression, collaboration and advocacy. While digital literacy initially focused on digital skills and stand-alone computers, the focus has shifted from stand-alone to network devices including the Internet and social media.

Digital games-based learning (edutainment). Learning methodology where children acquire digital literacy informally by playing games. To this end, it is important that multimedia design for training and education should combine the most powerful features of interactive multimedia design with the most effective principles of technologically-mediated learning.

Flipped Classroom. Is an instructional strategy and a type of blended learning that reverses the traditional learning environment by delivering instructional content, often online, outside of the classroom. It moves activities, including those that may have traditionally been considered homework, into the classroom. In a flipped classroom, students watch online lectures, collaborate in online discussions, or carry out research at home and engage in concepts in the classroom with the guidance of a mentor.

GAME BASED APPROACH IN LEARNING

In Educational Psychology it is generally accepted that games can provide a fruitful and effective learning environment. The whole idea stems out from the following benefits of the game approach:

Creating Interest and Promoting Motivation
A Game is a sequence of interesting choices. By engaging the learner in such a process motivation is activated and thinking (including critical one) is taking place.

Utilizing the Benefits That Games Provide in Engaging Learners in an Environment of Experiential and Active Learning
The interaction in a game creates a better understanding for the learners in regards to the objects, concepts, processes and even the other learners involved

Socializing the Persons Involved and Exploiting the Competition and Challenge Element
Games are part of everyday life-socialization. This is particularly important in the case of slow learners as their slowness might have its roots in their lack of social relations and interchanging eliminating ideas or low morale.

Connecting to Real Life Situations
Quite many games reflect actual activities of life and thus they provide the element of usefulness.

Developing a Happy and Joyful Environment

As already mentioned the joy element is a plus in the learning process.

Utilizing the Design (Structure, Rules, Equipment, Problem Posing etc) of a Game in Order to Develop an Appropriate Learning Approach

The components of a game, particularly the ones characterized by aesthetic, illustrative, energetic activities can be exploited for meaningful learning. Also the problem solving elements provide ample ideas for strategic and critical thinking.

Inquiry Based Learning. Educational technique that always begins with questions, problems and challenges (rather than presenting known facts or a ready-made solution).

The role of the teacher here is to pose the initial question to your students, then facilitate them in discovering answers. Ideally – and in order to meet the true definition of Inquiry Based Learning – that process involves them asking further questions.

Inquiry Based Learning is often used in scientific subjects, where there's likely to be a definitive answer for students to reach, often through a process of elimination, testing and trial and error. However, it can equally be applied to any subject.

Problem Based Learning. (PBL) is a student-centered approach in which students learn about a subject by working in groups to solve an open-ended problem. Rather than teaching relevant material and subsequently having students apply the knowledge to solve problems, the problem is presented first. Students generally must:

- Examine and define the problem.
- Explore what they already know about underlying issues related to it.
- Determine what they need to learn and where they can acquire the information and tools necessary to solve the problem.
- Evaluate possible ways to solve the problem.
- Solve the problem.
- Report on their findings.

Project Based Learning. While this technique also begins with a challenge or question, its remit tends to be wider. If Inquiry Based Learning is about discovering an answer, Project Based Learning is about exploring an answer. The aim here is that students gain and develop their knowledge and skills through working extensively to investigate and respond in detail to an issue that's engaging and complex, rather than clear-cut. For that reason, Project Based Learning is often used with literature, social and historical topics. It's also – in terms of outputs – a great opportunity for your students to create visual or multimedia material.

BRIEF DESCRIPTION AND AIM OF THE TRAINING

The DIS-CODE project aims to train students at drop out risk on improving digital skills and learning Maths by studying coding and practicing digital literacy skills, mainly through flipped class methods. According with this main goal, DIS-CODE partners developed a training course, focused on students between 12-18 years attending junior and upper secondary schools in the countries involved in the DIS-CODE project (Italy, Portugal, Belgium, Czech Republic and Cyprus). This training course aims to develop competences on digital literacy and Maths in students at drop out risk, especially by learning basics on how to program, by making them able to program and actively learn basics of coding and digital literacy skills. To learn coding means to keep up-to-date personal competences and transversal skills, such as problem solving, team work and analytical thinking.

The students taking part in the pilot test training are expected to be positively affected as for their personal and transversal skills, their school career in terms of engagement and improvement of numeracy. This training is supposed to be embedded into the normal curricula of the students in each country in the school year 2018-2019. **50 students and 2 teachers** per country are involved.

According to recent studies (Golpin, 2014), teaching basic coding can increase problem-solving skills: being able to follow programming logic and debugging a program trains the mind to think in more abstract and analytical ways.

Moreover, there are benefits beyond logical thinking too. When people learn computer programming, they learn how to check their work for details, how to apply logic and how to persist at a task. They also learn how to ask a good question, often in written form. Finally, they learn how to collaborate because much programming today is accomplished in teams. Furthermore, practicing digital literacy skills, for example by creating a digital story, fosters the acquisition of competences such as creativity, communication, media literacy, self-expression and – again – team work, if the work is done collaboratively. These timeless skills and learning behaviors will endure far longer than any programming language and will be needed in any type of job students would like to pursue beyond their school career.

The main activities of this training are:

- learning basic computer contents, whether needed (internet browser, email, MS Office, social networks), delivered by both professors (for theory and general supervision) and students, expert on coding, acting as “tutors” (for exercises and practical sessions).

- learning basic digital skills related to media literacy plus correlated elements of ICT-literacy. The proposed activities encourage collaboration as well as surfacing of talents normally neglected at school, thus re-vamping motivation.

- learning Maths with code by the methodology of Flipped Classroom, so they can feel a better accomplishment and personal satisfaction into their lives leading to a more active participation at school and better results at their curricula. Through flipped classroom model, students can focus

on learning by doing, with the teacher guiding the way, being the lecture no longer the driver of concept mastery.

- be part of a “DIS-coding” community based on the following tools: platform with life-assistance, games, a forum moderated on a daily basis, social network-groups. Such community is going to be possibly linked to existing movements and networks, in order to strengthen it.

LEARNING GOALS

Learning coding will empower participants to better understand maths and to do many things they would not otherwise be able to do, including hand-crafting their own websites, or shaping their educational path aiming at a career coder or even at starting a technology business. This will indirectly favor creativity and most importantly, it will improve their ability to understand the technology shaping our world.

The training will, therefore, focus on practical application of the knowledge acquired, so it will have access to Maths software, games, examples, case studies, exercises, showing how coding can be used for learning maths in a funny way, using non-formal techniques for teaching and learning, focus on real problems, considering that Maths is useful for real life.

Overall, participants will improve their digital abilities and be more prepared to face the technology progresses: basic computer training, mainly related to usage of application and programs useful for everyday life (Web Browsers, Microsoft Office, emails, Skype, Facebook, etc.), basic media literacy that allows them to create multimedia communication in a “professional“ way and to collaborate in shared cloud spaces.

At the end of this training, students should know the basics of computer programming: what it is about, what it serves for, how to use it, why it is important to learn coding, and be trained on basics of the most used programming language: Scratch.

Further, by using the flipped classroom method, students learning environment would get a strong impact in order to increase students’ engagement and decrease sense of frustration, through educational technology and activity based learning.

LEARNING METHODOLOGY

The training previewed in this project will be based on a student driven approach, where the students are the central part of the teaching-learning process, based on a personal learning environment, where teachers are facilitators of student active-learning. This faculty enables students to learn effectively and efficiently in varied environments. The power is shared with students so that they can be involved in the conditions of learning, learning by doing. This balance of power leads to greater student responsibility in the environment of work-based learning. Students are directly involved in the discovery of knowledge, using inquiry-based methods to understand and use the material. Students are actively engaged in their learning process. Evaluation

promotes learning, improvement, provides feedback, & results in competency decisions about students.

The training should also cover the problem-based learning (PBL) method, that is a student-centered approach in which students learn about a subject by working in groups to solve an open-ended problem. The problem is what drives the motivation and the learning. Rather than teaching relevant material and subsequently having students apply the knowledge to solve problems, the problem is presented first. Students generally must:

- Examine and define the problem.
- Explore what they already know about underlying issues related to it.
- Determine what they need to learn and where they can acquire the information and tools necessary to solve the problem.
- Evaluate possible ways to solve the problem.
- Solve the problem.
- Report on their findings.

Another teacher-learning method to be used in this training is the game-based learning (GBL) that is based in non-formal learning, i.e. should happen accidentally. GBL uses competitive exercises, either pitting the students against each other or getting them to challenge themselves in order to motivate them to learn better. Games often have a fantasy element that engages players in a learning activity through a storyline. In order to create a truly educational game, the instructor needs to make sure that learning the material is essential to scoring and winning.

Game-based learning has become the best solution for soft skills learning. We are suggesting to use some games inside the lesson plans inside Module 2 of this training. For instance, we suggest to use the Scrabble Maths game While classroom training and traditional e-learning formats are less didactic, hard to implement and costly, game-based courses are the best way to train soft skills in a fun, consistent and inexpensive way.

The main characteristics of game-based learning are:

1. The learning process takes place through different and attractive scenarios
2. The learning process is based on overcoming different challenges
3. The learning experience is positive and interesting

It is also important to highlight the fact that to create efficient game based learning it is essential to integrate a simulator that creates real situations and enable students to practice the skills. When we refer to soft skills training the use of video games is especially interesting. Soft skills need to be practiced in order to ensure learning.

This training will also adopt the flipped classroom approach. “Flipped classroom” means a pedagogical inversion of traditional class: actions that are used in class are now prepared by students previously to classroom. Therefore, when students come into class they already know what is main topic and more important problems that will be under scope. Classroom is used to debate, to do exercises, to perform experimental protocols, to further discuss main implications of

scientific issues related with course subject matter. This implies more active role of students and more challenging task of lecturers.

For further info, please see: www.uq.edu.au/teach/flipped-classroom/what-is-fc.html and www.edudemic.com/guides/flipped-classrooms-guide

MODULE ORGANIZATION

The training is organized in 3 main modules: Improve Digital skills, Numerical skills and Basics of computer programming. Then, the module 4 and module 5 are transversal modules which are present in the first 3 modules. Modules are blocks of contents about a certain set of topics, which include syllabi, learning objectives, methodology to be used, tools, and bibliography and some examples of lesson plans.

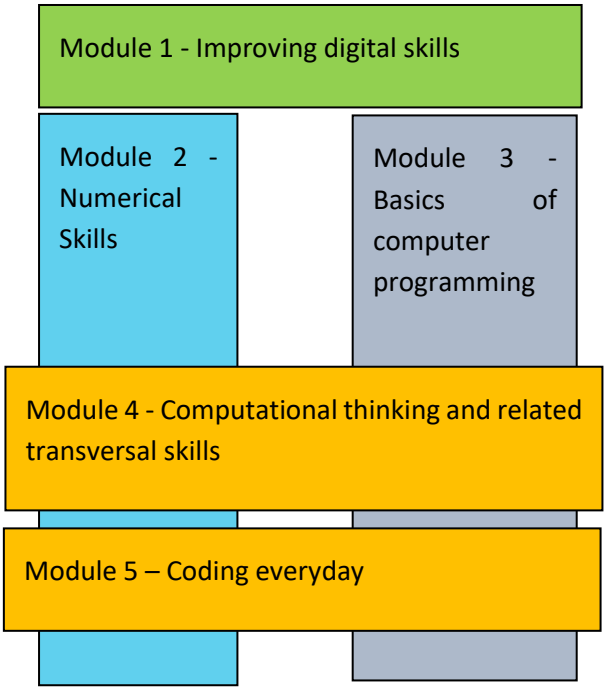
As we can see in the schema below, we planned a first module, that is introductory. In this module, teachers should explain to students basics of digital and media literacy, as well as basic digital competences, like audio, storytelling, collaborative tools and digital image.

In module 2, teachers will go deeper into several subjects of numerical sills, trying to use code and gamification in each Maths topic. We planned suggestions for lessons in Arithmetic, Algebra, Functions and Geometry.

In module 3, teachers have an introductory chapter of Scratch programming language. As Module 2 has many examples using this programming language, module 3 helps in how to manage Scratch, how to work in this environment and how to use its basic figures and tips.

Modules 4 and 5 are transversal modules, as they are totally present in the previous modules. Module 4 – Computational Thinking and related transversal skills is always present inside the Methodology and Assessment part of the other modules and Module 5 – Coding everyday is always present inside the Tools and Assessment part of the other modules. There we can see examples, tools of the suggested topic, as well as self-assessment examples, quizzes, etc.

Training Plan Schema



TARGET GROUP AND PRE-REQUIREMENTS FOR TRAINEES

The target group of this course will be at a first time a group of teachers who have already attended an in loco training in Brussels, in October 2017, where they learnt something about digital literacy, something about coding and something about edutainment.

In a second phase of this study, teachers will use this training plan to apply their contents and examples to their students, inside the classrooms. Students between 12 to 18 years and their innovative teachers and schools across Europe. Also, teachers and ICT advisers will work with the project to develop future classroom scenarios and pedagogical videos focused on coding, computational thinking and Maths. All of these resources will be promoted extensively by regional partners to a total of over 6500 schools.

SCIENTIFIC AREA

The scientific area covered by this training is Maths and ICT (Media literacy, ICT literacy).

Inside the Maths scientific area, the plan covers the Arithmetic, Algebra, Functions and Geometry, while inside Digital Literacy the plan covers topics about Digital audio editing, Cloud and collaborative learning, Digital StoryTelling and Digital imaging.

DURATION

The training will be carried out by 2 teachers in each country in the first approach. They will implement the training in their current curriculum, between December 2017 and May 2018. The training to students should have a duration of 40 hours, that completes about 2 months approx. of regular classes. Teachers can choose if they prefer to use the hours in a sequence or in a intermittent way. They can use 20h inside classroom and 20h of home study or home work.

At least teachers should use one lesson plan of the Module 1 – Improving Digital skills, 1 lesson plans of the Module 2 – Numerical Skills and 1 lesson plan of the Module 3. They should adapt these lesson plans to their reality or simply create another new lesson plan about the same subject.

MODULE 1 – DIGITAL SKILLS

NAME OF TOPIC 1: DIGITAL AUDIO EDITING

SYLLABUS

- Introduction
- Sound: a physical and psychophysical approach
- Recording and reproduction of sound
- Processing of sound
  Exercise: creation of a soundtrack for a video
- Digital audio at school
- Podcast
- Digital audio and web-pages
  Exercise: a "talk lesson" in 5 steps (creation of educational podcasts)

LEARNING GOALS

The course aims at improving digital skills and computer literacy, mainly related to analysis and elaboration of digital audio.

- Students will enhance their digital literacy in relation to analysis and elaboration of audio files
- Students will learn how to use podcasts to support meaningful educational experiences
- Students will improve their media literacy by experience how to create content for multimedia

It is now helpful to point out the learning outcomes related to the connection of Digital Audio with Computational Thinking. Speaking of **Audio Digital Settings** is clear that could be of interest the inclusion of **Computational Thinking** background in using audio digital skills to attract students to Computer Science and Maths.

The main idea is to learn students about the importance in the "Sound" and "Music" elements to be included into the computing learning and the related Maths topics.

Therefore, it is important to use the CT approach to analyze the concepts of "Sound" and "Music" by using the general principles of DECOMPOSITION - TRENDS - ABSTRACTION - RECOMPOSITION IN ALGORITHM DESIGN.

Major goals are:

1. Identify properties of sound and describe the organization of sound into music. Click here for further information http://historyofmusic.tripod.com/id6.html
2. Design a simple notation system and describe the differences between formal and informal notation. Click here for further information https://shemesh.larc.nasa.gov/fm/fm-what.html
3. Distinguish between analogic and digital audio. Click here for further information http://www.centerpointaudio.com/Analog-VS-Digital.aspx

4. Discuss the basic differences between various audio file formats and sound compression techniques. Click here for further information http://www.makeuseof.com/tag/audio-file-format-right-needs/

Given that students have not to become Digital Audio experts nor CT's professionals, the additional material we are proposing is more about to use the world of Music to be deepened with the use of Computational Thinking.

Most people love some kind of music. Some even dream of being rock stars, but the combination of computational thinking skills and an interest in music opens up even more exciting avenues. Audio engineers constantly change the way we both make and listen to music, from the formats we use to listen to music, to creating new forms of computer-generated musician. They can also use their skills to use sound in other novel ways, from anti sound that cuts out unwanted noise, to multimodal systems that give the blind new ways to interact with computers. Those with musical ability, computer science and electronic engineering skills together with a creative flair can both make new sounds but also change the way the rest of us make and use sound.

Here you can find some interesting material to apply to your lessons plan:

- https://cs4fndownloads.files.wordpress.com/2016/03/audioissue1.pdf
- http://www.cs4fn.org/music/

Of course, the use of the most popular coding software Scratch can be of help on using the power of Music to learn the secrets of new digital languages and their strict correlation with Maths, always by approaching these arguments with the Logical Reasoning and Mathematical Thinking, which are the basis of Computational Thinking.

METHODOLOGY

The modules of the course will be delivered online, in asynchronous mode. All the materials (lectures, activities, tutorials, slides, ...) are given from the beginning and not gradually. Each learner can manage autonomously her/his learning activities, i.e. can download and study materials and carry out activities whenever and wherever she/he wants. In addition, no moments or spaces of direct interaction during the study are provided (e.g. webinar, …).
The activity outcomes could be part of PoliCultura 2017/2018, a digital storytelling international competition organized by HOC-LAB (Politecnico di Milano).

SOCIAL COLLABORATION TOOLS AND ACTIVITIES

Online materials, slides, videos, background materials. This material will guide the learner through the content, providing her/him with the background both methodological and technological necessary to implement with pupils what learnt.

BIBLIOGRAPHY

➢ Introductions and biographies

- https://drive.google.com/open?id=0B_Hca1et3kpYYzhkUkFMQW9MT1U
- https://drive.google.com/open?id=0B_Hca1et3kpYRkM4Tzg4aUpzd28

➢ Course

- https://drive.google.com/open?id=0B_Hca1et3kpYWkdLOXdYTm1hRVE
- https://drive.google.com/open?id=0B_Hca1et3kpYNVJKcHZQYmp5Tk0

➢ Activities

- https://drive.google.com/open?id=0B_Hca1et3kpYVndKQWdsemNGT2c
- https://drive.google.com/open?id=0B_Hca1et3kpYQldBSVB4dE1VSDQ

NAME OF TOPIC 2: CLOUD AND COLLABORATIVE LEARNING

SYLLABUS

- Cloud architecture
- How to manage folders and editing permissions in a cloud environment
- How to manage documents, spreadsheets and online forms
- Educational formats for a creative use of the cloud in the classroom
  Exercise: Practical assignments on the specific tasks illustrated within the course

LEARNING GOALS

The course will be focused on the usage of cloud technology within an educational experience. It deals with technical knowledge and skills for collaborative working in a cloud platform. Cloud computing is seen as a key "enabler" for implementing innovative teaching and collaborative educational experiences.

- Students will learn how to use a cloud platform to support collaborative learning experiences.

It is now helpful to point out the learning outcomes related to the connection of Cloud Computing with Computational Thinking. **Computational Thinking** is an emerging basic skill that is set to become an integral part of higher education together with reading, writing, critical thinking, and problem solving. In general, Computational thinking is not only critical to all physical sciences but also highly relevant in other domains. CT is essential to the development of computer applications indeed, but it can also be used to support problem solving across all disciplines, including the humanities, math and science. Students who learn CT across the curriculum are able to see relationship between academic subjects, as well as between life inside and outside of the classroom.

Cloud Computing is not a completely new concept and it is closely related to grid computing: cloud computing is an approach of managing computing resources by increasing the capacity or adding the capabilities without having to invest (heavily) in new infrastructure, and train new personnel.

This enables students to use remote IT resources such as servers and storage, thus using applications not residing on their own hardware. As such, students can immediately practice all the techniques they have been taught, using any device at their disposal (laptop, desktop, tablet, smartphone or other mobile devices) to access the virtual systems online and administer the virtual computer through a web interface. It shall be easy on the part of the teachers to monitor the virtual machines and re-configure them whenever necessary. In addition, the data generated or acquired by the user also resides online, and the user has sole access to that data unless he or she decides to share it.

Embracing **cloud computing strategies** into your teaching methods enables students to focus more on thinking about the subject of their students, rather than worrying on the technological interface (both software and hardware) they come to interact with. At the same time, teachers may place more focus into their students' learning processes, as the variety of tasks and activities updated provides the student with the flexibility to choose and repeat the tasks to learn the techniques at their own pace, actually putting them in control of the whole learning process. Thus, this is a very practical way of approaching the transformation of how computational thinking is taught to students and more importantly on how students learn computation. Students will be able to easily identify the steps involved that could be documented and scripted, allowing them to understand the process more clearly. Enabling the creation of a "work-flow" and further allowing students the opportunity to refine the workflow, this approach allows students to adjust the process, cross-validate the results and see how and why the process has been personalized to obtain a better estimate.

METHODOLOGY

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SOCIAL COLLABORATION TOOLS AND ACTIVITIES

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BIBLIOGRAPHY

https://www.youtube.com/playlist?list=PL9pNjM0f4Ln3wOrUMpxOi5gWy8rpMKuZD

NAME OF TOPIC 3: DIGITAL STORYTELLING

SYLLABUS

- Introduction: digital narratives
- Technologies for creating digital narratives
- How to use the 1001stories tool
- Digital storytelling (DST) at school
- DST: educational impact
- DST: communication quality and media literacy
- How to validate results

LEARNING GOALS

The course focuses on the creation of digital narratives (Digital StoryTelling) with the *1001stories* tool (by HOC-LAB, Polimi). The key message is that telling stories using digital technologies has both an educational and communication value, and can play a crucial role in fostering technological competencies as well as soft skills.

- Students will learn how to create a digital story
- Students will learn how to organize a meaningful educational experience based on digital storytelling
- Students will acquire media literacy skills (multimedia communication)

METHODOLOGY

The course will be delivered online in an asynchronous mode. All the materials (lectures, activities, tutorials, slides, ...) are given from the beginning and not gradually. Each learner can manage autonomously her/his learning activities, i.e. can download and study materials and carry out activities whenever and wherever she/he wants. In addition, no moments or spaces of direct interaction during the study are provided (e.g. webinar, …).
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- https://drive.google.com/open?id=0B_Hca1et3kpYTlJvWF9LbmJaQ0E

Suggested further webography

http://storycenter.org/
Whether you are interested in storytelling for professional development, as a reflective practice, as a pedagogical strategy, or as a vehicle for education, community mobilization, or advocacy, you will find the assistance you need with us. We are recognized globally as experts in all things digital storytelling. Custom projects represent the majority of our work, even though we may be more well known for our Public Workshops.

BBC – How to write
How to write a novel, a screenplay, a radio play, memoirs. Get advice from famous writers.

Telling their stories
High school students at the Urban School of San Francisco conduct and film interviews with Bay Area Holocaust survivors in their homes. Students then transcribe each 2-plus hour interview, create hundreds of movie files associated with each transcript, and then post the full-text, full-video interviews on this public website as a service to a world-wide audience interested in Holocaust studies.

http://www.primaryaccess.org/
PrimaryAccess is a suite of free online tools that allows students and teachers to use primary source documents to complete meaningful and compelling learning activities with digital movies, storyboards, rebus stories and other online tools.

http://www.digitales.us/
Digital Storytelling takes the ancient art of oral storytelling and engages a palette of technical tools to weave personal tales using images, graphics, music and sound mixed together with the author's own story voice.

Storytelling and new media narrative
A page just for digital storytelling was created due to the demand for information about Jason's workshops and the area in general.

NAME OF TOPIC 4: DIGITAL IMAGING

SYLLABUS

- Theory of colour
- The formation of colour and of the digital imaging and representation
- GIF and PNG format
- JPEG format
- Formats used by cameras
- Tutorials on image-editing program (GIMP)
- Tutorials on how to create a shooting set

Exercise: “101 square meters”, a tale in 10 pictures. Participants are required to shoot 10 pictures all related to their own “space” (e.g. a day of their life) and to stitch them together in a meaningful way.

LEARNING GOALS

The course will be focused on image editing, representation and storage. The course explains how digital images are made and how they can be modified, illustrating the most common formats.

- Students will learn how to efficiently modify, manage and exchange digital images in view of the production of multimedia applications

It is now helpful to point out the learning outcomes related to the connection of Computational Photography with Computational Thinking. Computational Thinking and photography merge in **Computational Photography**, a field which describes the convergence of computer graphics, computer vision, and the Internet with photography. Computational Photography aims at overcome the limitations of traditional photography using computational techniques to enhance the way we capture, manipulate, and interact with visual media. The field of computational photography is creating new ways of image-making that are machine-readable representations of our experience, and that is a big shift.

How did the change occur? Traditional photography has always been about capturing a single frame, like a frozen moment in time: the more light you gather, the better you can do that. However, that is not the way the eye works. In fact, our eyes are constantly scanning a dynamic scene in real time, assembling our image of the world in our brains. We combine information captured at different times to get more out of a scene than our eyes as cameras can extract in a single “frame” (if they had frames).

Computational photography adds smart digital algorithms not just to single frames, but to quickly shot sequences of them, or frames from multiple different lenses. It uses those to learn more about the image than any frame or lens could process. What it does is very interesting, but one key factor is it lets you get better results with lesser lenses and sensors. What used to take a big lens and a big sensor gets done almost as well by smaller, cheaper, lighter ones, even the ones we can have in our phones.

The trick about computational photography is to use the time factor to compensate for the poor size of your lens and sensor. If your scene isn’t moving much, you can combine a series of quick images to get most of the information a big lens would have captured in one shot. You can digitally stabilize the images so that even though the camera is not being held still, you can align the frames together. You can even see what parts of the frame are stable and which are changing, and track different components and improve them independently.

In a way, this is what the human brain does with the “analytical camera” which work through our eyes. The eye’s sensor is sharp only in the middle, and the lens not so large but the brain combines signals from two cameras over time to give you what you think is a sharp and well-defined view of the world.

METHODOLOGY

The course will be delivered online in an asynchronous mode. All the materials (lectures, activities, tutorials, slides, ...) are given from the beginning and not gradually. Each learner can manage autonomously her/his learning activities, i.e. can download and study materials and carry out activities whenever and wherever she/he wants. In addition, no moments or spaces of direct interaction during the study are provided (e.g. webinar, …).
The activity outcomes could be part of PoliCultura 2017/2018, a digital storytelling international competition organized by HOC-LAB (Politecnico di Milano).

SOCIAL COLLABORATION TOOLS AND ACTIVITIES

Online materials, slides, videos, background materials. This material will guide the learner through the content, providing her/him with the background both methodological and technological necessary to implement with pupils what learnt. In using images taken form the web, it is relevant to point out the issue of plagiarism and authorship: please refer to single national regulation. In general, it is needed to say that a proper credit should be provided for all pictures that are found online and free to use. Here the explanation of a Creative Common License of Attribution-ShareAlike 4.0 International (CC BY-SA 4.0) https://creativecommons.org/licenses/by-sa/4.0/

BIBLIOGRAPHY

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➢ Course
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➢ Activities and Tutorials
- https://drive.google.com/open?id=0B_Hca1et3kpYTy1uMGlxU0VfdHc
- https://drive.google.com/open?id=0B_Hca1et3kpYOFFfdGR3MEhjb0E
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EXAMPLE FOR LESSON PLAN: DIGITAL AUDIO: PODCASTING AND SOUND ANALYSIS AND EDITING AT SCHOOL

TOPIC/ DIGITAL SUBJECT**:** ICT and Media literacy: introduction to podcasting at school and to sound analysis and elaboration in pedagogical and learning environment.

APPROACH/ METHOD TO BE USED**:** Introducing the basic of both theoretical and practical concepts of sound analysis and elaboration and the use of podcasting at school, the course aim to motivate and to provide teachers and students knowledge to use digital audio instruments as useful tools in instructional and pedagogical environment. All this with different instructional moments:

explanations by teachers and instructions, collaborative work in small groups, individual activities and critical thinking activities.

TARGET GROUP: Students at middle school and high school, from 11-18 years old

OBJECTIVES:

Obj1. To discover the nature of sound theory with a psychophysical approach
Obj2. To understand and use the sound recording and reproduction in relation to the different formats
Obj3. To understand the diffusion of sound in relation to the different formats
Obj4. To understand and use the sound editing ad mixing techniques the different
Obj5. To understand what is a Podcast and its use at school
Obj6. Create and develop a personal Podcasting referring to learning and instructional situation

MEANS/ TOOLS/ EDUCATIONAL TECHNOLOGY

Computers, the Internet, a set of programs for audio recording and editing

BRIEF DESCRIPTION OF THE PLAN IN THE CONTEXT OF THE DIS-CODE METHODOLOGY

The educational activity with Digital Audio (Podcasting and Sound analysis and editing) aims at empowering and fostering digital skills related to audio, settled in context of multimedia production and communication, with a special regard to collaborative and project-based approach. The overall goal is to enhance ICT and Media literacy, especially related to the capability of working with Digital Audio in order to create, in a second moment, a multimedia product.
The topic, even if is not directly related to curricular subject, is meaningful for a classroom activity, (e.g. a special project, a school outing…). Students are supposed to work both individually and collaboratively, organized into groups. The inner organization within the groups can vary: e.g., they can be heterogeneous in terms of performances and /or in terms of roles. Two main strategies are possible: either all students try all activities (recording of audios, writing of texts, editing of audio…) or students work at what fits best their talents. The main idea is to improve both individual capabilities and collaborative skills, in relation to ICT domain.

PLAN FOR WORK

Time	Activities	Methods/ means
2 weeks earlier than the classroom considerati on	Introduce the activity and the subject, providing motivation for the topic Show some examples of digital audio activities and introduce students to the most important tools. Investigate interest/acceptance by the class.	Show at least 2 or 3 examples of digital audio activities Organize working groups, tasks and deadlines (it may be helpful to use shared

	Motivate the class. Select a topic. Organize groups. **Organizational hints:** **Hint 0** – motivate the students by letting them know what they are about to create will be published on the web and be broadcast: it is something everybody will listen to. It has to be clear and pleasurable (authentic learning activity). **Hint 1** – ask the students what they know about audio and digital audio **Hint 2** – ask the students how technology can help to edit and analyze digital audio **Hint 3** – the power of technology, how simple PC programs can help to modify and work with digital audio: the importance of editing emotional message **Hint 4** – decide if you want to work with heterogeneous or homogenous groups, in terms of performances and capabilities. Heterogeneous groups guarantee quality level of the outcomes across the class, but the risk is that the best performing students do most of the work; homogenous groups compel low-performing students to work, but this may lead to results that are not of the same quality with respect to other groups in the class	spreadsheet and cloud environment) HELPFUL LINKS: https://drive.google.com/open?id=0B_Hca1et3kpYYzhkUkFMQW9MT1U https://drive.google.com/open?id=0B_Hca1et3kpYRkM4Tzg4aUpzd28 https://drive.google.com/open?id=0B_Hca1et3kpYWkdLOXdYTm1hRVE https://drive.google.com/open?id=0B_Hca1et3kpYNVJKcHZQYmp5Tk0
In the classroom on the planned day for the lesson / At Home /	**Hint 5 –** think together and discuss about ideas and impressions on topics received 2 weeks before **Hint 6 –** Narration and audio: ask their opinions and ideas on how a good editing can modify a story, also in relation to learning goals and school context	Show on the projector In class (it may be helpful to use shared spreadsheet and cloud environment)

		https://drive.google.com/open?id=0B_Hca1et3kpYWkdLOXdYTm1hRVE https://drive.google.com/open?id=0B_Hca1et3kpYNVJKcHZQYmp5Tk0
	Hint 7 – Working in group: ask students to select a topic and try to write a text for a digital broadcasting **Hint 8 –** Devote a plenary session to this activity so that the final narrative is "everybody's choice". Support the discussion with something visible and easily manageable (e.g. poster + post-it, the blackboard) **Hint 9 –** Students have to find the "raw" content for the story by scavenging the internet ("information literacy"), going to the library, gathering materials of various kinds from outside the school contexts (e.g. pictures of the territory) **Hint 10 –** if the topic allows it, find external "experts" to be interviewed is a good way to find valuable content. "Experts" could be also relatives as well as public authorities or scholars	Computer Shared spreadsheet and cloud environment blackboard https://drive.google.com/open?id=0B_Hca1et3kpYVndKQWdsemNGT2c https://drive.google.com/open?id=0B_Hca1et3kpYQldBSVB4dE1VSDQ
	Hint 11 – Discovering together programs for digital audio: every group selects a different story and create a digital audio. Students have to integrate the program recently learnt and their collaborative capabilities	Computer Shared spreadsheet and cloud environment

	Hint 12 – Reflect on the activity done and share ideas and opinions	Computer Shared spreadsheet and cloud environment blackboard

ASSESSMENT/ FEEDBACK

As regards the topic dealt with: provide multiple choices test on the topic; ask students to write an essay on their understanding of the topic.
As regards ICT literacy: observe the students during the activity and provide an evaluation based on their performances.
As regards media literacy: provide an evaluation, group-by-group, based on the quality of the result.
As regards group work competencies (collaboration, leadership, negotiation…): self-assessment group by group plus assessment by the teacher (through observation).

EXAMPLE FOR LESSON PLAN: CLOUD COMPUTING IN CLASSROOM

TOPIC/ MATHEMATICAL SUBJECT**:** ICT and Media literacy: introduction to cloud computing at school and collaboration and cooperation in pedagogical and learning environment.

APPROACH/ METHOD TO BE USED**:** Introducing the basic of both theoretical and practical concepts of cloud computing and methodologies for sharing, cooperation and collaboration synchronous and asynchronous. The course aim to motivate and to provide teachers and students knowledge to use cloud computing instruments (in particular SaaS, Software as a Service, e.g. Google Drive) as useful tools in instructional and pedagogical environment. All this with different instructional moments: explanations by teachers and instructions, collaborative work in small groups, individual activities and critical thinking activities.

TARGET GROUP**:** Students at middle school and high school: from 11-18 years old

OBJECTIVES**:**

Obj1. To discover the difference between sharing, cooperation and collaboration

Obj2. To enhance collaboration and cooperation among students

Obj3. To understand the importance of working together for a common goal

Obj4. To comprehend the importance of the respect for each other in complex cooperative works (netiquette, importance of each part of the work, negotiation attitudes)

Obj5. To improve the understanding of different roles using role playing activities

MEANS/ TOOLS/ EDUCATIONAL TECHNOLOGY

Computers, the Internet, a cloud computing SaaS tool (e.g. Google Drive)

BRIEF DESCRIPTION OF THE PLAN IN THE CONTEXT OF THE DIS-CODE METHODOLOGY

The educational activity with cloud computing enable students to complete several projects by interacting with their group members online and submit the results online working both in class or at home, making the process easy and quick.

Teacher and students are able to access software and data from a multitude of devices, and teacher can foster different models, using the ownership of several files/directories and changing in useful ways the sharing properties. Students and teachers can as well use these generally free technologies to ease the partnership together with engagement in face-to-face, online, and blended courses.

The topic, even if is not directly related to curricular subject, is meaningful for a classroom activity, (e.g. a special project, a school outing…). Students are supposed to work both individually and collaboratively, organized into groups. The inner organization within the groups can vary: e.g. they can be heterogeneous in terms of performances and /or in terms of roles. Two main strategies are possible: creation of homogeneous or heterogeneous groups: in the first case is possible to avoid the risk that the most skilled students in each groups make all the work. In the second case an interchange of different skills is desiderable. The main idea is to improve both individual capabilities and collaborative skills, in relation to ICT domain.

PLAN FOR WORK

Time	**Activities**	**Methods/ means**
2 weeks earlier than the classroom consideration	Introduce the activity and the subject, providing motivation for the topic Show the difference between sharing, collaboration and cooperation and introduce students to the chosen cloud computing tool. Create the accounts. Investigate interest/acceptance by the class. Motivate the class.	Show at least 2 or 3 examples of sharing – cooperative – collaborative activities Organize working groups, tasks and deadlines

	Select a topic. Organize groups. **Organizational hints:** **Hint 0** – motivate the students by letting them know that the common work will grow together and that each role is very important for a good result. **Hint 1** – ask the students what they know about cloud computing **Hint 2** – ask the students to imagine new ways / activities to be carried on in collaboration **Hint 3** – try to use cloud computing activities to carry on a real project, e.g. a digital storytelling activity, a website, a blog, etc. (authentic learning) **Hint 4** – decide if you want to work with heterogeneous or homogenous groups, in terms of performances and capabilities. Heterogeneous groups guarantee quality level of the outcomes across the class, but the risk is that the best performing students do most of the work; homogenous groups compel low-performing students to work, but this may lead to results that are not of the same quality with respect to other groups in the class	Explain the importance of respect and netiquette in collaborative environments
In the classroom on the planned day for the lesson / At Home /	**Hint 5 –** think together and discuss about ideas and impressions on topics and new proposal to use cloud computing made by the students **Hint 6 –** Try an activity of co-editing synchronous and in real time: this kind of activity is really effective from a motivational point of view.	Show on the projector In class Brainstorming activity (pop corn methodology)
	Hint 7 – Working in group: ask students to select a topic and try to write a text together **Hint 8 –** create together an useful environment in the cloud, explaining the difference between shared and private files/folders **Hint 9 –** Integrate the cloud computing activity with other activities carried on in class or at home	Computer Shared spreadsheet and cloud environment
	Hint 11 – Discovering together new ways to cooperate and different tools for cloud computing: the Internet offers a wide range of tools and asking students to find a new one can create a good sense of autonomy.	Computer Shared spreadsheet and cloud environment

	Hint 12 – Reflect on the activity done and share ideas and opinions	Computer Shared spreadsheet and cloud environment

ASSESSMENT/ FEEDBACK

As regards the topic dealt with: provide multiple choices test on the topic; ask students to write an essay on their understanding of the topic.

As regards ICT literacy: observe the students during the activity and provide an evaluation based on their performances.

As regards media literacy: provide an evaluation, group-by-group, based on the quality of the result.

As regards group work competencies (collaboration, leadership, negotiation…): self-assessment group by group plus assessment by the teacher (through observation). In this case the respect of netiquette is very important and must be pushed.

EXAMPLE FOR LESSON PLAN: DIGITAL STORYTELLING

TOPIC/ DIGITAL SUBJECT**:** Media literacy, ICT literacy

APPROACH/ METHOD TO BE USED**:** a medley of instructional moments – i.e., explanations by the instructor (15%), collaborative work in small groups for carrying out the actual work (70%), critical thinking activities – i.e., revision of the work done by all in plenary sessions (15%).

TARGET GROUP: Students from 11-18 years old

OBJECTIVES**:**

Obj1. To learn more on the subject-matter dealt with in the narrative

Obj2. To gain media-literacy, i.e. the ability to communicate combining various media (video, audio, images, text…).

Obj3. To gain ICT-literacy (ability to use a number of SW programs: authoring tool for Digital Storytelling, programs for audio-recording, for image-editing, for video-editing….)

Obj4. To improve the ability of working in groups, with related competences (collaboration, negotiation, leadership…)

MEANS/ TOOLS/ EDUCATIONAL TECHNOLOGY

Computers, the Internet, an authoring tool for digital storytelling (e.g. 1001stories by HOC-LAB, Polimi), a program for audio-recording, a program for image editing, a program for video editing.

BRIEF DESCRIPTION OF THE PLAN IN THE CONTEXT OF THE DIS-CODE METHODOLOGY

The educational activity with Digital Storytelling is aimed at fostering digital skills of various kinds, related to multimedia production and communication, in the context of a project-based approach. The overall goal is to create a multimedia (combining text, audio, images, videos…), interactive (i.e. split into chunks the user can navigate) "narrative".

A topic is selected to be the focus of the narrative (either by the teachers – for lower grades – or by the teachers in collaboration with the students – for higher grades). The topic is meaningful for a classroom activity, i.e. either directly connected to the curriculum (e.g. a curricular subject) or to a school activity (e.g. a special project, a school outing…). Students are then organized into groups, with each group in charge of a specific chunk of the "narrative" to be built. The inner organization within the groups can vary: e.g. they can be heterogeneous in terms of performances and /or in terms of roles. Two main strategies are possible: either all students try all activities (recording of audios, writing of texts, editing of images…) or students work at what fits best their talents. When all groups are done with the their work, the narrative is put together using an authoring tool: critical sessions are held where students decide what to amend/improve until a final, satisfactory version is reached.

Nowadays there is a proliferation of storytelling practices that aims to train children to an important 21st century skill, the computational thinking, from a very young age. Pre-programmed games in tablets, e-books, animations, handy online tools can be identified as pretty evident examples of how digital devices and other media support computational thinking and playful storytelling. Learning to program using simple tools helps to promote problem solving, creativity, thinking mathematically and using logic and reasoning in children.

Creating a successful digital story whether it is a presentation, movie, animation or a project, aside from preparing a great story or script, often comes down to planning. Planning includes:

1. Having clear objects/outcomes about what you need to achieve with the task;
2. Understanding what will we assessed;
3. Assign roles to your team;
4. Gathering resources (scripts or stories), actors, physical or digital backdrops and props;
5. Arrangement of a storyboard;
6. Preparing for how the story will be captured/ created and how it will be shared and viewed by an audience.

Going through these structured phases means to put in practice strategic skills and logical frameworks related to computational thinking. Putting together a storyboard entails breaking a narrative unit into different chunks (or frames), performing a first DECOMPOSITION which then is going to be re-assembled following a selected DESIGN of rules and principles. The PATTERNS RECOGNIZED help authors to find and identify recurrent narrative elements which may establish the backbone of a new story, building on them to develop original plots and course of actions.

PLAN FOR WORK

Time	Activities	Methods/ means
In the classroom - Launching of the activity WEEK 1	Introduce the activity, select a topic Show some examples of digital narratives created by other groups of students, possibly of the same school level. Investigate interest/acceptance by the class. Motivate the class (very important!). Select a topic. Organize groups. **Organizational hints:** **Hint 0 –** motivate the students by letting them know what they are about to create will be published on the web: it is something everybody will see, read, listen to. It has to be clear and pleasurable (authentic learning activity). **Hint 1** – decide whether you want to have heterogeneous or homogenous groups, in terms of performances. Heterogeneous groups guarantee quality level of the	Show at least 3 examples of digital narratives: http://www.1001storia.polimi.it/meusGEN/meuslive.php?public=1&projectid=1340 http://www.1001storia.polimi.it/meusGEN/meuslive.php?public=1&projectid=1340 http://hoc12.elet.polimi.it/generate/expo2015/p_942/ Organize working groups, tasks and deadlines (shared spreadsheet?).

	outcomes across the class, but the risk is that the best performing students do most of the work; homogenous groups compel low-performing students to work, but this may lead to results that are not of the same quality with respect to other groups in the class. **Hint 2** – decide whether you want all the students to try all the activities or if you want to let each student follow her talent. If everybody tries everything, then educational benefits from the activity will be more equally spread; if each student can work according to her talent, probably motivation will be higher and the quality of results as well. **Hint 3 –** decide whether you are letting students organize themselves into groups (with adjustments by you) or if you are making the groups (better for lower grades). **Hint 4** – discuss the topic with the students: provide some suggestions (3-4) and see the reactions; or (higher grades) ask them to propose a topic.	Helpful materials: https://drive.google.com/file/d/0B_Hca1et3kpYeWQ1YkkxMWd0LVE/view?usp=sharing https://drive.google.com/file/d/0B_Hca1et3kpYYWtrRlVKM1pGZ0k/view?usp=sharing https://drive.google.com/open?id=0B_Hca1et3kpYbl9FQ2RFMFJfQkk https://drive.google.com/open?id=0B_Hca1et3kpYRTRMOUxYbkQwUTA https://drive.google.com/open?id=0B_Hca1et3kpYbVUxYjR3VFY3cFU https://drive.google.com/open?id=0B_Hca1et3kpYMVVtUG5PTlViUUU

		https://drive.google.com/open?id=0B_Hca1et3kpYZmhWUldHUmZXbEk
In the classroom – **storyboard creation** WEEK 1	Students decide how to articulate the narrative (chapter and sub-chapters). **Hint 5**: devote a plenary session to this activity so that the final narrative is "everybody's choice". Support the discussion with something visible and easily manageable (e.g. poster + post – it, or the blackboard).	Big paper posters and colored post-it to support discussion and organization of the narrative's structure. https://drive.google.com/open?id=0B_Hca1et3kpYeTJYbDVSNEZFU2c
In the classroom/at home/out of school – **content finding** WEEK 2	Students have to find the "raw" content for the narrative by scavenging the internet ("information literacy"), going to the library, gathering materials of various kinds from outside the school contexts (e.g. pictures of the territory). **Hint 6**: if the topic allows it, finding external "experts" to be interviewed is a good way to find valuable content. By experts we mean relatives as well as public authorities or scholars.	Computers (for finding texts, images, videos…) Camera (for taking pictures) Paper and pencils/colors: for creating drawings to be scanned Recorder for the interviews https://drive.google.com/open?id=0B_Hca1et3kpYeTJYbDVSNEZFU2c
In the classroom/at home **content refinement** WEEK 3	Students, according to the roles they have in the group, work at creating and refining the content: texts, images, audios… **Hint 7:** give priority to verbal communication and have the visual communication serve it.	Computer SW for editing images/videos SW for recording audios https://drive.google.com/open?id=0B_Hca1et3kpYeTJYbDVSNEZFU2c https://drive.google.com/open?id=0B_Hca1et3kpYMWZ3N0xDQ2pWY0E

In the classroom/at home **content entry in the authoring tool** WEEK 4	Once all the elements of the narrative are ready, they must be entered into the authoring tool. NOTE 1: this phase is ideally placed after the preceding phases of content gathering and preparation; it can start though earlier as small pieces of content are ready. E.g. a small chapter of the story could be introduced in the authoring tool before, to see how the result looks like NOTE 2: who does the data entry? It depends; in some cases, it is the teacher (for a number of reasons, ranging from poor connectivity at school to young age of the students). In other cases, it is the most tech-savvy among the students; in others, it is all the students.	Computer Authoring tool for digital narratives https://drive.google.com/open?id=0B_Hca1et3kpYRTRMOUxYbkQwUTA https://drive.google.com/open?id=0B_Hca1et3kpYeTJYbDVSNEZFU2c
In the classroom **evaluation sessions** WEEK 5	In classroom, plenary session(s). The completed narrative is shown to the class; critical comments are gathered; round of re-design are run to get to the final version.	Computer; video projector https://drive.google.com/open?id=0B_Hca1et3kpYLWx2VUVENC1FX1U

FINAL NOTE: 5 weeks (3/4 hours a week in the class – more work at home by the students) are a reasonable time for creating a medium-sized digital narrative (about 20-25 minutes) with a reasonable research work on content on a topic. Teachers may decide to devote more time to: dig deeper into the topic and the related research work (thus aiming at cognitive benefits in relation to the topic dealt with); devote more time to the refinement of the content (thus aiming at media-literacy benefits); devote more time to technical aspects (thus aiming at ICT-literacy benefits).

ASSESSMENT/ FEEDBACK

As regards the topic dealt with: provide multiple choice test on the topic; ask students to write an essay on their understanding of the topic.

As regards ICT literacy: observe the students during the activity and provide an evaluation based on their performances.

As regards media literacy: provide an evaluation, group-by-group, based on the quality of the result.

As regards group work competencies (collaboration, leadership, negotiation…): self-assessment group by group plus assessment by the teacher (through observation).

EXAMPLE FOR LESSON PLAN: DIGITAL IMAGES AND PHOTOGRAPHIC LANGUAGE

TOPIC/ DIGITAL SUBJECT: Introduction to digital images and photographic language

APPROACH/ METHOD TO BE USED: Introducing the basic and theoretical concepts of images and photographic language, the course aim to motivate and to provide students useful tools to interpret images and realize photographs

TARGET GROUP: Students from 11 to 18 years old (Junior High School and high School)

OBJECTIVES:

Obj1. To discover the color theory as a phenomenon of light

Obj2. To understand the structure of a digital image

Obj3. To understand and use the GIF format for digital images and use them in personalized web pages

Obj4. To comprehend and use the JPEG format for digital images.

Obj5. To understand the different image's format used by digital cameras

Obj6. Use GIMP program for simple graphics needs

Obj7. Develop a personal language to describe reality or imagination through the power of photography

TOOLS

Camera, Computers, the Internet

BRIEF DESCRIPTION OF THE PLAN IN THE CONTEXT OF THE DIS-CODE METHODOLOGY

Some pictures are given to the students, a couple of weeks earlier than the date of the classroom discussion of the topic, in order to begin to take confidence with images and interpretation of visual language (motivation phase). During the course, with a set of hints, the students are asked to experiment the tips learnt at lesson in group work sessions (cooperative learning) or at home.

Through a heterogenic learning process, constituted by theoretical texts about colors and light and practical tools, as image manipulation programs, the course aims to trigger a digital competences acquisition, which can be promoted through different hints, proposed across the lesson (e.g. Observe images and being able to find out the color language; put in practice image manipulation using technological tools; improve its own observation of reality and creative expression through the camera). Final aim of the process is to encourage in the student an individual and personalized output.

WORK PLAN

Time	Activities	Methods/ means
2 weeks earlier than the classroom consideration	Observe some pictures and reflect on the emotional use of colors. What the different colors used make you feel? Make up your own theory of emotions connected to colors. **General Ideas for Reflection in order to solve the Problem:** **Hint 1** – ask the students what they know about colors **Hint 2** – ask the students how technology can help to improve and change images **Hint 3** – the power of technology, how simple PC programs (GIMP) can help to modify images and their emotional message **Hint 4** – go back to the pre-lesson activity, and verify if the suggestions you got previously are still effective (getting ready for the activity n. 1 *Words and photography*) **Hint 5 –** narration and images. Read a short story or a newspaper article and find in google pictures which might illustrate the topic, the energy and the emotion of the text (getting ready for the activity n. 2 *101 square meters!*) To achieve a proper output from this activities you can use the Internet to get information, GIMP program (you can download it for free from the internet) and Google Images.	Provide images/pictures To go through this activity you can use the internet, google images, camera, photo editing programs. HELPUL LINKS: https://drive.google.com/open?id=0B_Hca1et3kpYbGU2UGd4cmpVY2c https://drive.google.com/open?id=0B_Hca1et3kpYUjMzTDF2QWlSb0E
In the classroom on the planned day for the lesson	Observe in group the pictures received 2 weeks before and discuss together about ideas and impressions.	Show on the projector

		https://drive.google.com/open?id=0B_Hca1et3kpYT29iOWZaX2hLdGM
	Working in group, ask students to modify the same picture using the tools they already know.	Computer https://drive.google.com/open?id=0B_Hca1et3kpYT29iOWZaX2hLdGM https://drive.google.com/open?id=0B_Hca1et3kpYTy1uMGlxU0VfdHc
	Discovering together GIMP program; every group selects a different emotion to be expressed through the same picture. Students have to integrate the program recently learnt and their emotional awareness.	Computer https://www.gimp.org/ https://drive.google.com/open?id=0B_Hca1et3kpYTy1uMGlxU0VfdHc
	Reflect on the activity done before the beginning of the course	Show on the projector
	In classroom, after reading a text, in group students choose some pictures in order to create a visual narrative.	Computer https://drive.google.com/open?id=0B_Hca1et3kpYT29iOWZaX2hLdGM https://drive.google.com/open?id=0B_Hca1et3kpYOFFfdGR3MEhjb0E

At Home	Ask the pupils to: - Look for interesting pictures on Google Images - Modify pictures using the tools acquired at lesson - Choose picture and modify it in order to express a specific meaning or emotion - Make their own pictures looking for a specific meaning or emotion - Create a visual narrative using google pictures or their own pictures	Computer Internet Use of camera Use of photo editing programs https://www.gimp.org/ https://drive.google.com/open?id=0B_Hca1et3kpYOFFfdGR3MEhjb0E https://drive.google.com/open?id=0B_Hca1et3kpYZWRPbHFyZmVYOFE https://drive.google.com/open?id=0B_Hca1et3kpYNHZzVnBfcjlsOE0
Next day	Present the examples Assess	Discussions Use of digital photo editing programs and digital tools

ASSESSMENT/ FEEDBACK

- Create a multiple-choice test covering cognitive issues
- Create a multiple-choice test about images (e.g. given 3 pictures and 3 short narratives, match the picture to the adequate paragraph)

SELF-ASSESSMENT

- In small group (3/4 people) students work on a given picture (photo editing). They are then asked to modify it to make it fit a specific communication goal (e.g. social media post). The final product is evaluated by the other groups and finally the authors are asked to self-evaluate their own work.

MODULE 2: NUMERICAL SKILLS

NAME OF TOPIC 1 - ARITHMETIC

The Remainder Theorem

INTRODUCTION TO THE COURSE

The relation connecting division and multiplication in the set of integers is one of the most basic processes in Number Theory and actually it provides similar ideas in the domain of many other rings (for example the ring of polynomials over $\mathbb{R}$). Furthermore, the ideas behind it give rise to the concepts of equivalent classes in the set of integers and to modular arithmetic.

TARGET: Students from 11-13 years old

DURATION: This particular lesson is expected to be covered in 2-3 teaching hours

EFFORT FOR THE STUDENTS: Approximately 4-5 hours

SYLLABUS

In arithmetic, **Euclidean division** is the process of division of two integers, which produces a quotient and a remainder. This is a theorem that states that the quotient and remainder exist and are unique, under some conditions. Because of this uniqueness, *Euclidean division* is often considered without referring to any method of computation, and without explicitly computing the quotient and the remainder. The methods of computation are called integer division algorithms, the most well-known being long division.

Euclidean division, and algorithms to compute it, are fundamental for many questions concerning integers, such as the Euclidean algorithm for finding the greatest common divisor of two integers, and modular arithmetic, for which only remainders are considered. The operation consisting in computing only the remainder is called the *modulo operation*.~

DESCRIPTION

The material that is presented through the Lesson Plan provides opportunities for Introducing the concepts and processes involved studying the remainder theorem through the development of motivation and interest. Furthermore, it approaches the topic by stressing the steps that help a student in solving a problem. The connection of the approach with everyday issues and

LEARNING GOALS

The students will KNOW

The basic concepts involved in the remainder theorem, that is the dividend, D, the divisor, d, the quotient, q, and the remainder, r, where D, d, q and r are integers

The Euclidean relation connecting these concepts

$D= d.q+r,$ with $0\leq r < 0$

The process of finding q and r, when D and d are given

They shall be able to apply the Euclidean division (the Remainder Theorem) in solving problems

They shall be able to use digital means in order to apply the process of the Euclidean division

They shall be able to apply the Polya approach for solving a problem

The course will provide opportunities for

Developing skills for problem solving

Meeting situations that develop motives and positive affective tendencies for mathematics

Experiencing opportunities to see applications of the related concepts and processes in the real world

Presenting/ explaining the value of the remainder theorem

Developing digital skills/ through the use/ exploitation of digital means as help/ support in calculations.

METHODOLOGY

A word problem is given to the students, a couple of weeks earlier than the date of the classroom discussion of the topic, with a set of hints and the students are asked to collect information (eg by using the Internet or other references) and solve the problem at home either alone or by discussion and cooperation with their peers. The problem should create interest for investigation and provide motives for this. It should also be given to the students a set of instructions for identification of the various mathematical terms they have met in previous years and their relations. Then in the classroom the students present their findings and the whole class proceeds to a systematic consideration of the remainder theorem and the various concepts and processes involved as a review/ recapitulation of the work they have done at home.

BIBLIOGRAPHY

FURTHER INFO

Arithmetic and Number theory

The quotient remainder theorem (article) | Khan Academy

https://www.khanacademy.org/computing/.../a/the-quotient-remainder-theorem

Leap year - Wikipedia

https://en.wikipedia.org/wiki/Leap_year

NAME OF TOPIC 2 - ALGEBRA

Manipulation of Algebraic Expressions

INTRODUCTION TO THE COURSE

The approach aims at introducing and provide opportunities for consolidation of the concepts of variables and the use of simple algebraic properties in manipulating algebraic expressions through the exploitation of a game, the AlgebraScrabble. It makes available to the students to design their own game and helps in understanding the concepts of variables and equalities as well as the properties of operations and their priorities.

TARGET GROUP: Students from 11-13 years old
DURATION: 3 teaching periods
EFFORT OF THE STUDENTS: 5 to 6 hours

SYLLABUS

Revise the following concepts and processes:
Comprehend and use the properties of the Operations of addition, subtraction, multiplication and division in the sets of integers, rational and real numbers.
Comprehend the priority of operations in the above sets using the symbols “(,)” as well
Write, read and evaluate numerical expressions involving numbers in the sets of integers, rational and real numbers using the previously mentioned notation.
Extend the above mentioned activities to include the concept of positive integral powers
Write, read and evaluate numerical expressions that are the outcome of applications in everyday activities, using the previously mentioned notation.

Extend the ideas in an abstract context;
Assign symbols to represent variables in various cases.
Write and read and interpret the meaning of expressions in which letters stand for numbers.
Write, read, and evaluate expressions in which letters stand for numbers.
Apply and extend the previous understandings of arithmetic expressions to algebraic expressions.
Write expressions that record operations with numbers and with letters standing for activities in the context of simple applications
Identify parts of an expression using mathematical terms (sum, term, product, factor, quotient, coefficient).
View one or more parts of an expression as a single entity.

Use properties of operations to generate equivalent expressions.
Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients.
Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related.
Students work closely with the expressions that define the functions, competently manipulate algebraic expressions, and continue to expand and sharpen their abilities to model situations and to solve equations, including solving quadratic equations
Use variables in simple algebraic expressions and equalities to describe relationships.
Evaluate algebraic expressions for specific values of the variables
Simplifying algebraic expressions using one or more algebraic expressions; translating statements, using algebraic equalities.

LEARNING OBJECTIVES

To comprehend the concepts of a variable, of an equality, an algebraic expression using the operations of addition, subtraction, multiplication and division as well as raising to positive integral powers.
To Observe the priority of operations in an algebraic expression.
To Develop communication skills through the use of mathematical language and symbolism.
To make models of mathematical ideas through the use of algebraic expressions
To know the basic properties of the above operations and relations
To Manipulate algebraic expressions in simple cases: For example, adding, subtracting multiplying polynomials with up to two variables and of degrees less than or equal to 3.
To realize that making their own models is a powerful means of building understanding and explaining their thinking to others.
To comprehend that through the manipulation of algebraic expressions they are helped to:
• see patterns and relationships;
• make connections between the concrete and the abstract;
• test, revise, and confirm their reasoning;
• remember how they solved a problem;
• communicate their reasoning to others.
To develop positive attitudes towards mathematics
To develop interest in mathematical concepts and processes through the advantages that educational games offer

METHODOLOGY

In the spirit of the flipped classroom method the students are asked to create the tools for the MathScrabble game and understand its rules for playing it. By abiding to these rules they are guided in manipulating algebraic expressions and thus develop the appropriate skills.

BIBLIOGRAPHY

http://www.math-aids.com/Algebra/Pre-Algebra/Expressions/

FURTHER INFO

Evaluating Algebraic Expressions Basketball Game (for computers and iPads) New In this two-player game students will evaluate various expressions with http://www.math-play.com/evaluating-algebraic-expressions-basketball-game.htmlntegers

NAME OF TOPIC 3: ALGEBRA

Graph of a function

INTRODUCTION TO THE COURSE

One of the strong assets of mathematics is that they provide models for describing real world problems. One of the approaches in the representation of such real world problems is through functions leading to equations. Such equations can be solved approximately by sketching the graphs of the functions involved. The sketching of such functions can be easily achieved through digital means, like software for sketching graphs. Furthermore, the representation of graphs can provide illustrative approaches for studying and analyzing such functions. Also, it is well mentioning that through real world problems the students are motivated and realize the value of mathematics.

TARGET: Students from 16-18 years old

DURATION: 3 teaching periods

EFFORT FOR THE STUDENTS: 6 to 7 hours

SYLLABUS

The various concepts of the definition of a function

Recognize that functions are sets of ordered pairs

Understand that a function assigns to each element of the domain exactly one element in the range

Represent a function through a graph

To graph and analyze functions, to find numerical solutions to equations

Understand how a function is analyzed using its representation as a graph

Interpret key features of graphs (e.g increasing/ decreasing, maxima/ minima etc.)

Use function (and their graphs) to model relationships between variables

Write and graph a function in the form of an algebraic, trigonometric, exponential or logarithmic expression, in various forms and interpret its behavior

Modeling relationships by functions and use digital means in graphing them.

Determine explicit expressions of implicitly determined functions or relations between a number of variables.

Use the properties/ characteristics of the graph of function to solve problems.

To relate the graph of function to the approximation of solutions of equations.

To model a situation mathematically

To develop skills for problem solving

To develop motives and positive affective tendencies for mathematics

To identify/ develop/ create applications of the related concepts and processes in the real world

To develop digital skills/ through the use/ exploitation of digital means as help/ support in calculations.

DESCRIPTION

The approach for this topic evolves around a series of important mathematical concepts that are employed for modeling a real life problem through the development of functions and algebraic expressions. These expressions then are represented graphically, thus providing illustration of their behavior. From the graphs we then interpret the various concepts involved and thus we deduce solution to the problem. Furthermore, from the graph we may have the opportunity to realize the existence of a solution, which we can approximate as there are usually many difficulties in obtaining exact values.

LEARNING GOALS

The students will know:

The students are expected to understand the various concepts immediately related to a function.

How to identify variables related in a particular real life situation

To sketch the representation of a function given as an explicit expression

That using digital means the sketching becomes an easy activity

The students will be able:

To develop a mathematical model through the stating of mathematical entities like equations, inequalities etc.

To analyze the representation of a function by a graph and use it to determine characteristics of the function like monotonicity, maxima or minima etc.

ATTITUDE the course will foster

The lesson will provide opportunities for

Developing skills for problem solving

Meeting situations that develop motives and positive affective tendencies for mathematics

Experiencing opportunities to see applications of the related concepts and processes in the real world

Developing digital skills/ through the use/ exploitation of digital means as help/ support in calculations

METHODOLOGY

The sketching of the graph of a function is one of the areas of mathematics where the contribution of digital means is immense and has facilitated both the comprehension as well as the analysis of the properties and the characteristics of a function. Thus, the topic should make extensive use of such means. Furthermore, a systematic learning of the problem-solving methodology is of paramount importance. The Polya's approach (understand the problem, devise a plan, implement the plan and then assess and investigate) has proved to be a very effective and it is a very strong asset in the solution of a problem.

RESOURCES

Discovering Algebra Resources - Kendall Hunt

http://math.kendallhunt.com/x6983.html

Advanced Sketch Gallery - The Geometer's Sketchpad Resource Center

www.dynamicgeometry.com/General_Resources/Advanced_Sketch_Gallery.html

Manuals of various graph sketching software packages

G. Polya: "How to solve it"

Problem Solving | STEM

https://www.stem.org.uk/resources/community/collection/25049/problem-solving

NAME OF TOPIC 4: GEOMETRY

Pythagoras Theorem

INTRODUCTION

In order to help the students comprehend what the background basis of the theorem is, they are provided with a visual approach, which makes use of the idea of the area of a simple polygon. Through this approach the students are led to the relation of the sides of a right-angle triangle.

Then they practice by considering exercises, including ones with real life applications.

TARGET GROUP: Students from 14-15 years old, in a secondary school

DURATION: 2 to 3 teaching periods

EFFORT OF THE STUDENTS: About 4 to 5 hours

SYLLABUS

Students understand the statement of the Pythagorean Theorem and its converse,

They can explain why the Pythagorean Theorem holds, for example, by decomposing a square in two different ways.

They can prove the Pythagorean Theorem

They apply the Pythagorean Theorem in real world problems

They apply/ use the Pythagorean Theorem In solving problems in Euclidean Geometry

LEARNING GOALS

To identify the basic constituents of a right-angle triangle

To state the Pythagoras theorem.

To prove, apply and use the Pythagoras theorem

To explain various visual representations of the theorem and exploit them in the proof of the theorem

To solve real world problems, using the theorem

To state and prove the inverse of the theorem

To develop skills for problem solving

To identify/ develop/ create applications of the related concepts and processes in the real world

To develop digital skills/ through the use/ exploitation of digital means as help/ support in calculations, visual representations of the concepts, processes involved in handling the theorem

To develop critical thinking skills

To adopt various strategies for problem solving

To develop motives and positive affective tendencies for mathematics

To exploit technological means

METHODOLOGY

As a first step the students are asked to construct at home a puzzle that after proper rearrangements leads to the conclusion that under certain conditions the sum of the areas of two squares is equal to the area of a third square. The students are then asked to specify what these conditions are.

As a second step, the students are given a figure and are asked to prove at home certain propositions that can lead to the Pythagoras Theorem.

Furthermore, the students are asked to surf in the Internet about Pythagoras and the historical roots of the theorem

BIBLIOGRAPHY

FURTHER INFO

Pythagorean Theorem Proofs, Lesson Plans, Class Activities, Science ...

www.juliantrubin.com/encyclopedia/mathematics/pythagorean_theorem.html

Pythagorean Theorem and its many proofs

www.cut-the-knot.org/pythagoras/

Pythagorean theorem | mathematics | Britannica.com

https://www.britannica.com/topic/Pythagorean-theorem

EXAMPLE FOR A LESSON PLAN: ARITHMETIC – THE REMAINDER THEOREM

TOPIC/ MATHEMATICAL SUBJECT: Introduction to the Remainder Theorem of Arithmetic

APPROACH/ METHOD TO BE USED: Introducing the concepts and processes involved in this topic through the development of motivation and interest - Practice the concept in context of coding

TARGET GROUP: Students from 11-13 years old, in a secondary school

OBJECTIVES:

General Objectives

ObjGen1. To develop skills for problem solving

ObjGen2. To develop motives and positive affective tendencies for mathematics

ObjGen3. To develop digital skills/ through the use/ exploitation of digital means as help/ support in calculations.

ObjGen4. To exploit the flipped classroom method for supporting the various processes

Specific Objectives

ObjSpe1. To comprehend the terms dividend, divisor, quotient, remainder in the set of integers

ObjSpe2. To express the relations of the above terms in mathematical form (equality and inequality)

ObjSpe3. To acquire the skill of finding the quotient and the remainder in the division of two integers, using traditional and digital means

ObjSpe4. To comprehend the range of values of the remainder.

ObjSpe5. To present/ explain the value of the remainder theorem

ObjSpe6. To identify/ develop/ create applications of the related concepts and processes in the real world

TOOLS

Calculators, Computers, the Internet, a spreadsheet (e.g Excel)

- Explanation of the Remainder theorem process and real examples of it - http://www.math-only-math.com/dividend-divisor-quotient-and-remainder.html
- Videos that will explain long division, quotient, dividend, divisor and remainders - http://www.onlinemathlearning.com/quotients-remainders.html

- Simple exercises to play with Remainder theorem - https://www.mathsisfun.com/numbers/division-remainder.html
- Materials for teaching the Remainder Theorem - https://www.education.com/lesson-plan/divide-and-conquer/
- Applying a game to the Remainder Theorem https://books.google.pt/books?id=ipHxCQAAQBAJ&pg=PA81&lpg=PA81&dq=games+dividend+dividend+quotient+remainder&source=bl&ots=1Sz4QI9knf&sig=i4gyyappvtJqYrsUkbE2QXPz-Aw&hl=pt-PT&sa=X&ved=0ahUKEwiG-N7o653VAhUKXhQKHcbTAxE4ChDoAQgpMAE#v=onepage&q=games%20dividend%20dividend%20quotient%20remainder&f=false
- Computational Thinking Resources:
  - http://www.bbc.co.uk/education/topics/z7tp34j
  - http://www.curriki.org/
  - https://edu.google.com/resources/programs/exploring-computational-thinking/
- Scratch

BRIEF DESCRIPTION OF THE PLAN IN THE CONTEXT OF THE DIS-CODE METHODOLOGY

Logical reasoning

In computing students use laws of inference to predict what programs will do from their source code, to detect and correct errors in algorithms and programs and to analyse the efficiency and correctness of algorithms; students learn about Boolean logic and its applications to circuits, programs and search. Program execution by CPUs relies on logic gates.

Mathematics is underpinned by set theory and logic. Mathematical reasoning is fundamentally logical reasoning. In Maths, students will be expected to ‘show their working’ and to provide a justification for their answer. They form a basic understanding of sets and their relationship, which is later formalized through diagrams and theory.

A word problem is given to the students, a couple of weeks earlier than the date of the classroom discussion of the topic, with a set of hints and the students are asked to collect information (e.g. by using the Internet or other references) and solve the problem at home either alone or by discussion and cooperation with their peers. The problem should create interest for investigation and provide motives for this. It should also be given to the students a set of instructions for identification of the various mathematical terms they have met in previous years and their relations. Then in the classroom the students present their findings and the whole class proceeds to a systematic consideration of the remainder theorem and the various concepts and processes involved as a review/ recapitulation of the work they have done at home.

WORK PLAN

Time	Activities	Methods/ means
2 weeks earlier than the classroom consideration	Give a problem for investigation and for providing a motive A religious sect, using the information of their written texts and the opportunities provided by the power of computers, came to the conclusion that the end of the world will occur on the First day of one of the next centuries that will happen to be a Sunday. Given that a century ends on a year with the last two digits being 0 (i.e. of the form …00), find the year that will be the end of the world. **General Ideas for Reflection in order to solve the Problem:** **Hint 1** Do we know a few examples of what is meant as the name of the first day of a century? Do we know what was the name of the first day of the year 2001? Do you know how to find the name of day after, say, 55 days from today? What arithmetical operation are involved? What concepts from the primary school do you use? **Hint 2** How can we determine the name of the first day of a year knowing the first day of the previous year? **Hint 3** How many days does a year have? Which years are considered as leap years? **Hint 4** How many days does a century have? Can you determine a pattern for the name of the first day of each century? For the solution of this problem you can use the Internet to get information, as well as your calculators or the Excel MS software or any other digital means you like.	Provide written document Use the first step of computational thinking: it is a problem solving process that includes a number of characteristics and dispositions. First step is: Decomposition. A university professor once said: “If you can’t solve out a problem, then there is an easier problem you can solve: find it!”. You can apply this advice to any problem by identifying easier to solve smaller-problems within larger ones’ decomposition For the solution of this problem you can use the Internet to get information, as well as your calculators or the Excel MS software or any other digital means you like.

In the classroom on the planned day for the lesson 15 min	Consider the simple problem Today is Monday. What is the name of the day after 55 days? How do you find it? What arithmetical operations are involved? What are the terms involved in the division of integers and how are they related?	In the process of observing, breaking down a problem into easier to solve smaller pieces you are likely to have noticed similarities and patterns Patterns are opportunity for efficiency when solving problems Being able to recognize patterns is a fundamental step of the Computational Thinking because patterns help you determine what operations can be done Patterns allow operations to be repeated, saving time Discussion Use of calculators
15 min	What is a leap year? Which centuries start with a leap year? What is the number of days of a century? What is the solution to the given problem?	Example of how to use the third step of Computational Thinking: Abstraction: Identifying the general principles that generate these patterns. Abstraction is identifying and extracting relevant information to define main ideas Abstraction lets one object stands for many and allows us to deal with complexity and scale Using what you learned by recognizing patterns, relevant variables can be identified, grouped and generalized So that they define the main ideas of a problem Discussion Use of Excel and possible reference to the related functions
15 min	Given two integers D and d, what is the quotient and what is the remainder of the division D÷d? How are these numbers related?	Use the forth step of CT: Algorithm Design: Developing the step by step instructions for solving this and similar problems Discussion Presentations of relations
	Provide a set of simple exercises for consolidation and assessment	Example: A necklace is constructed from 20 blue beads and 14 red beads. Red beads

		0.33 eur each; blue beads 0.22 eur each; thread 0.14 eur per inch, 24 inches. 24 inches are required WHAT IS THE TOTAL COST OF THE MATERIALS FOR THE NECKLACE? To solve the problem write down the steps to create the algorithm: 1. BREAK THE PROBLEM DOWN INTO ITS COMPONENTS blue beads - ..... - trhead - costs - ..... 2. IDENTIFY SUBPROBLEMS THAT NEED TO BE SOLVED Subproblem 1 - Find the cost of each quantity of material ..... Subproblem 2 - Add the cost of all materials together ..... 3. RECOGNIZE PATTERNS BETWEEN SUBPROBLEMS Find the cost of blue beads Find the cost of..... ..... The subproblem 1. can be solved in p.....since any specific order is needed. This is called P.....

		The subproblem 2. is s..... The cost of each material has to be calculated in order. 4. SET UP OPERATIONS THAT CAN BE USED FOR THE SUBPROBLEMS Material cost x Material q..... = Total c....
At Home	Ask the pupils to create problems using the previous ideas with examples of the real world. For example someone deposits for a fixed period an amount on a certain date and it matures in a year. If it happens that on the maturity date there is a strike at the bank ,when will he be eligible to get his money back? Create other problems of the real world relating to the remainder theorem but with ideas different from the one above (having to do with modulo 7)	
Next day	Present the examples Assess	Discussions Use of digital means

ASSESSMENT/ FEEDBACK

Provide material that will help in realizing the achievement of the objectives:

Multiple choice test covering both cognitive and affective domain issues

Division with Remainder Game - In this soccer game, students will practice different division with remainder problems. The game can be played individually on the computer and the iPad, or in two teams on the smart board as a classroom activity - http://www.math-play.com/division-with-remainder-game.html

Example of quiz about the Remainder Theorem - http://www.kwiznet.com/p/takeQuiz.php?ChapterID=1375&CurriculumID=3

Self-assessment:

Reflection of what went well and what wrong on using this plan in a class.

ADDENDUM

IDEAS FOR DEVELOPING DIGITAL SKILLS BASED ON THE PREVIOUS LESSON PLAN THROUGH THE USE OF SCRATCH

(after the mathematics lessons and the introduction to Scratch in module 3)

90 min	Exploring and testing the project Divisibility by two Assembling groups • Group work at computers • Task: modify the project for divisibility by 3, 4 etc. • Groups have the project available for testing and a printed handout to discuss and write necessary modifications • Implement the modifications • Submit the work • Testing the work of other groups	https://scratch.mit.edu/projects/168385403/ work in groups of 3, PC for each group and for the teacher, projector/screen
90 min	Program a game for testing divisibility (such as https://scratch.mit.edu/projects/168528242/#editor) • Variables: revision • Operators: revision	1:1 lesson – PC for every pupil, PC for the teacher, projector/screen

EXAMPLE FOR A LESSON PLAN: MANIPULATION OF ALGEBRAIC EXPRESSIONS

TOPIC/ MATHEMATICAL SUBJECT: Manipulation of Algebraic Expressions

APPROACH/ METHOD TO BE USED: Introduction and Consolidation of the concepts of variables and the use of simple algebraic properties in manipulating algebraic expressions through the exploitation of the game AlgebraScrabble.

TARGET GROUP: Students from 11-13 years old, in a secondary school

OBJECTIVES:

General Objectives

ObjGen1. To develop digital skills/ through the use/ exploitation of digital means as help/ support in calculations.

ObjGen2. To exploit the flipped classroom method for supporting the various processes.

Specific Objectives

ObjSpe1 To Develop the sense of a variable and comprehend the meaning of an algebraic expression

ObjSpe2. To Develop the sense of equality.

ObjSpe3. To Comprehend the properties of equality.

ObjSpe4. To Manipulate algebraic expressions in simple cases: For example, adding, subtracting multiplying polynomials with up to two variables and of degrees less than or equal to 3.

ObjSpe5 To Observe the priority of operations in an algebraic expression.

ObjSpe6. To Develop communication skills through the use of mathematical language and symbolism.

ObjSpe7. To make models of mathematical ideas through the use of algebraic expressions. Students need to understand that making their own models is a powerful means of building understanding and explaining their thinking to others.

ObjSpe8. To comprehend that through the manipulation of algebraic expressions they are helped to:

- see patterns and relationships;
- make connections between the concrete and the abstract;
- test, revise, and confirm their reasoning;
- remember how they solved a problem;
- communicate their reasoning to others.

ObjSpe9. To present/ explain/ calculate the value of an algebraic expression for particular values of the variables involved.

TOOLS/ EDUCATIONAL TECHNOLOGY

The game AlgebraSvcrabble, Calculators, Computers, the Internet, a spreadsheet (e.g Excel)

- Online Tux Maths Scrabble - https://sourceforge.net/projects/tuxmathscrabble/
- Number Scrabble - the Game - http://www.instructables.com/id/Number-Scrabble-The-Game-aka-Math-Scrabble/
- Video about how to play the game Equate - https://www.youtube.com/watch?v=H1AjxUwjxlU
- Scratch

BRIEF DESCRIPTION OF THE PLAN IN THE CONTEXT OF THE DIS-CODE METHODOLOGY

The idea of the AlgebraScrabble game is given to the students, a couple of weeks earlier than the date of the classroom discussion of the topic, the assignment of producing the Board and the tiles for the game using simple material at home (for example cardboard). Some hints are given to start producing equalities using the symbols they are already familiar (numerical digits, symbols of arithmetic operations, parentheses, the symbol of equality). It is suggested to start playing the game as the ordinary scrabble with the use of numerical equalities in place of words.

This idea should create interest for investigation of what happens if instead of numbers we use letters that represent such entities. Then in the classroom the students present their findings and the whole class proceeds to a systematic consideration of the concept of a variable and of an algebraic expression.

PLAN FOR WORK

Time	**Activities**	**Methods/ means**
2 weeks earlier than the classroom consideration	Give a description of the Game AlgebraScrabble as it is presented in the Appendix. Hint 1 Ask the students to read the description of the game and reflect on the idea of playing the ordinary game Scrabble, but instead of words they use equalities involving numerical expressions. Hint 2	Provide written document as in the Appendix describing the game Use of material that they feel will achieve the best illustrative results

	Ask the students to construct (using digital means if possible) the Board and the tiles for the game Hint 3 Ask the students to start producing equalities using the symbols they are already familiar, e.g. 3+5=8 2•3=9-3 2•5-4=7-1 Hint 4 Ask the students to start producing equalities using the extra symbols they have already constructed, e.g. 2x+3x=5x	
In the classroom on the planned day1/period1 for the lesson	Discussion of the ideas of the students as developed through their involvement in constructing the game AlgebraScrabble and their reflections for the various symbols involved	Discussion
	Is it possible to give meaning of what is represented by each symbol? What does it represent? What do we fell that is represented by expressions like the ones below: 2y, 3x+4	Discussion Demonstration by modeling real situations

	3x2+x(x-2) Can we evaluate these for different values of the variables x and y? Can we use these expressions as models? Give more examples as they are provided in the textbook used by the particular class.	
	Observing the properties of operations and equalities (as known in arithmetic) simplify expressions like the following 3x+4x …. Ask for such activities using exercises from the textbook stressing the proper use of the symbol "="	Discussion Presentations of relations
At Home	Given sets of tiles from the game AlgebraScrabble ask the students to develop Valid equalities and evaluate the scoring they can get from each of them, observing for optimum solutions. For example Given the set of symbols *{2, x, 3, y, xy, +, 1, -, =, =, 5, (,)}*	
	Provide a set of simple exercises for consolidation and assessment of manipulation of algebraic expressions from the students textbook.	
In the classroom on the planned day2/period2 for the lesson	Start playing the game with 4 players and all the others attending their movements and construction of equalities. The equalities are placed on the Board and the scoring is obtained the proper way. A spreadsheet can be used for calculating and keeping the score	Discussion and exchange of ideas. Select proper strategies

At Home	Ask the pupils to play the game in pairs (or by having 3 or 4 players and one as coordinator, using electronic media for communication)	
Next day	Present the examples Assess	Discussions Use of digital means

Plan for work for Scratch

(after the mathematics lessons and the introduction to Scratch in module 3)

30 min	Introduction to strings and equality testing in programming (explained by teacher) Exercise: Implement a simple quiz with True/False questions about equalities and answers given by the user	frontal lesson, testing 1:1
90 min	Maze game improvement: Multiple exits from the maze, only one with (not visible) prize, player must answer questions at forks to get hints where to go • Redraw maze, identify forks • Prepare questions – equalities to be tested (and correct answers) • Implement one question as a prototype, test it • Clone to enable more questions in one maze • Implement the full maze with equality testing • Mutual testing (trying each others' games and equalities) Further development: more efficient and flexible question handling, using lists, randomness, automatic question generation…	1:1, groupwork

ASSESSMENT/ FEEDBACK

Provide material that will help in realizing the achievement of the objectives: multiple choice test covering both cognitive and affective domain issues

Self-assessment

- Quiz about equations - https://www.mathgames.com/skill/3.77-write-variable-equations-to-represent
- Different quizzes about Algebra - https://www.mathgames.com/algebra

REMARK

The above plan should be adapted according to the requirements of the specific syllabus, textbooks and other material used in each specific school.

APPENDIX

The Game AlgebraScrabble

THE DULLNESS OF HANDLING ALGEBRAIC EXPRESSIONS

An area of school mathematics that introduces students in the first stages of abstract thinking concerns the handling of **algebraic expressions**. It is an area that is based on a number of concepts and processes that do provide a lot of difficulties to the students, without the immediate provision of elements of their value, both in the context of applications and in the context of developing skills like problem solving, communication, critical thinking and so on. It is also an area with **immediate interest for Coding** in an age where ICT is becoming a dominating area of the Human condition.

In an Algebra Course for students at the ages 14 to 16 it is quite essential that they develop skills for comprehending the concept of a variable, the meaning of operations and their properties and for handling **equalities** that are valid in the context of a set with algebraic structure (e.g the real numbers). Some examples of such equalities are the following:

10⁄5=2

2+3=5+x-x

3(x+y)=3x+3y

(x+2y)x=x2+2xy

x2=x^2

4xx=2^2x2 or 4·x·x=2^2·x2

(x+y)^2=x2+2xy+y2

(2x+6)2=x+3

In order to develop such skills, we can make use of the Game we call AlgebraSrabble. It is a game similar to the **Word Game "Scrabble"**. The whole idea is to **construct equalities** instead of words which are the object of the traditional Scrabble.

THE GAME ALGEBRASCRABBLE

The game is built around a game board and involves 2-4 players. Also, there are a number of tiles with digits, variables or simple mathematical symbols on them (as presented in the tables that follow)

Each player has to construct valid equalities on a board, vertically or horizontally, using the tiles that he/she has or ones that are already on the board, like a crossword. Each tile carries certain points and the players are trying to use them in order to collect as many points as possible.

The whole idea is based on the construction of **valid equalities** vertically and horizontally forcing the other players to minimize theirs and to maximize the points earned at each step.

It is a game that contributes to the realization of the concept of equality and in the comprehension of the basic rules of algebra. Furthermore, it has the additional value of improving the numerical skills of the players through the calculation of the scores according to specified rules.

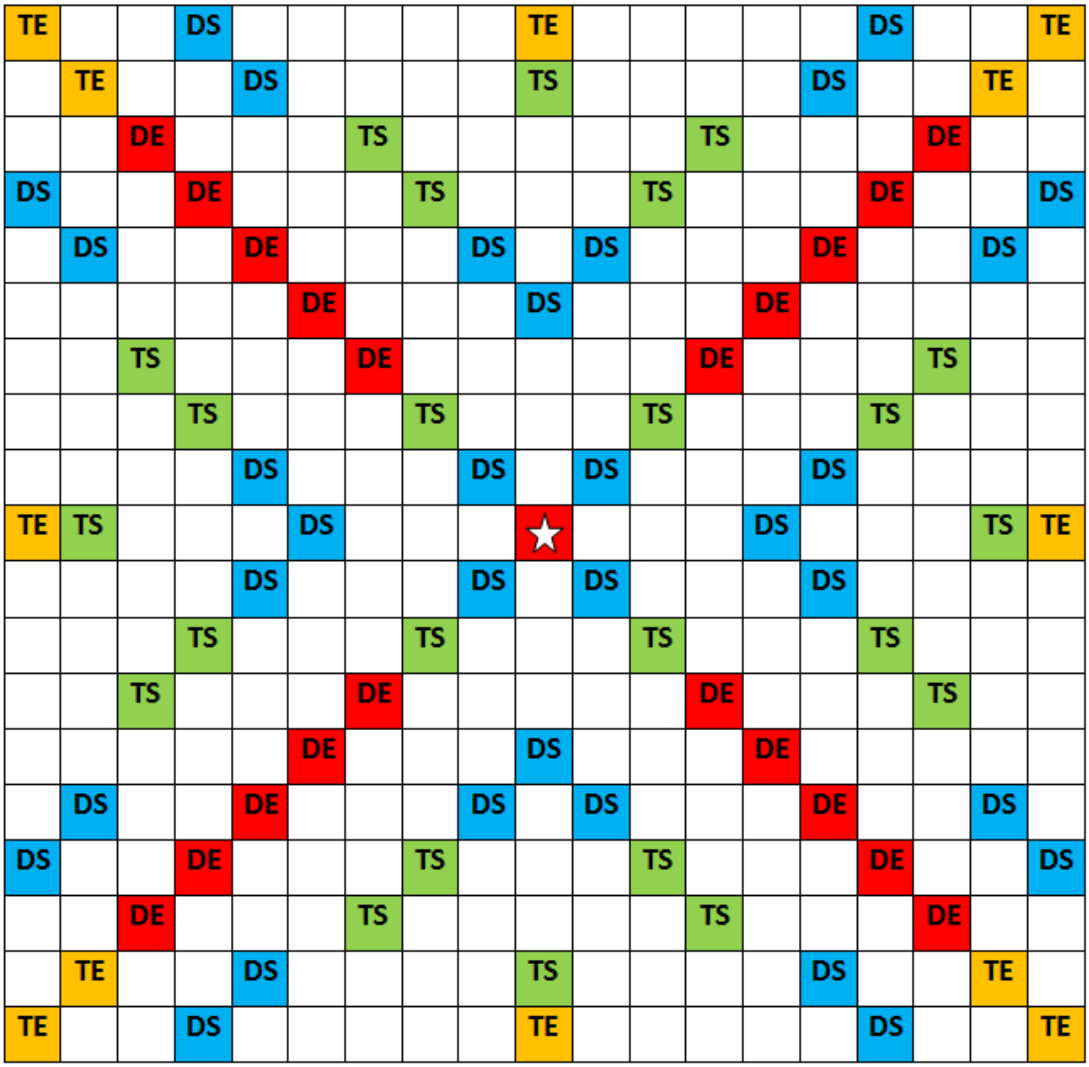
Objectives of the Game

- To construct equalities in a horizontal or vertical form using the available tiles according to certain rules.
- To count the points corresponding to each equality or equalities formed by a player in his/her last round and add them to form a total score for the player up to this round.
- To continue playing taking turns up to the point when there are no more tiles to be used or the players are not in a position to form any more equalities.
- The player with the highest score wins the game. Thus, the Goal of the game is "**to collect the Highest Score**".

BASIC EQUIPMENT

For the playing of the game the following pieces of equipment are essential:

First a game board consisting of 19X19 squares and having the following form.



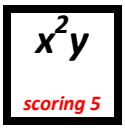
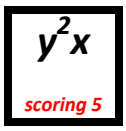
MEMO FOR THE NOTATION

TE	Triple the score corresponding to the equality using such a cell
DE	Double the score corresponding to the equality using such a cell
TS	Triple the score corresponding to the symbol using such a cell
DS	Double the score corresponding to the symbol using such a cell
★	Triple the score corresponding to the equality using such a cell

Second a number of tiles (160) each representing a mathematical symbol and carrying also a small number at its lower corner corresponding to the value of the points it provides for the score:

TABLE PRESENTING THE TILES THAT ARE USED IN THE GAME

Mathematical symbol	Form of corresponding tile	Number of available tiles for a game	Scoring value when used	Representing/ Meaning
1		5	1	The digit 1
2		6	1	The digit 2
3		6	1	The digit 3
4		6	3	The digit 4
5		5	2	The digit 5
6		6	2	The digit 6
7		4	4	The digit 7
8		5	2	The digit 8
9		5	2	The digit 9
0		5	2	The digit 0

x		5	2	Variable x
y		5	2	Variable y
x^2		3	3	Variable x^2
xy		3	3	Variable xy
y^2		3	3	Variable y^2
x^3		2	4	Variable x^3
y^3		2	4	Variable y^3
x^2y		2	5	Variable x^2y
y^2x		2	5	Variable y^2x
¤		4	0	Joker (can stand for any symbol) according to the player's declaration
^2		2	4	The previous symbol/ expression to the second power
^3		2	4	The previous symbol/ expression to the third power

√	√ scoring 4	2	4	Square root of the symbol/ expression that follows
(	(scoring 3	8	3	Opening parenthesis
)	) scoring 3	8	3	Closing parenthesis
+	+ scoring 3	10	3	The symbol for addition or the sign of a positive number
–	– scoring 3	12	3	The symbol for subtraction or the sign of a negative number
/	/ scoring 4	6	4	The symbol for division
=	= scoring 2	21	2	The symbol for equality
•	• scoring 2	5	2	The symbol for multiplication in case there is a need for clarification
		160		

RULES OF THE GAME

CARD 1 Rules for Playing the AlgebraScrabble Game

ALGEBRACRABBLE RULES - RULES FOR PLAYING

1. Each player takes initially **13 tiles** randomly (either from the bag, or by randomization using a computer).
2. Then each player is expected to construct, if possible, a valid equality using all or some of the tiles in his hand.

3. The first player that has a valid equality has to place it on the board by placing the symbol "=" in the central square (denoted by the star) and by arranging the other tiles either horizontally or vertically.
4. An equality can be read horizontally or vertically.
5. In each turn a **new (additional) symbol "="** can be used only once, that is if a player has in his/ hers hand two or more symbols "=" he/ she is allowed to use at most one of them for his/hers turn.

A player can construct a valid equality by constructing a new equality or by extending an existing one by using already positioned tiles on the board for developing one or more new ones, that is expressions with more than two equal parts (e.g. x2=x2=x·x)

6. Each player keeps always 13 tiles in his hand, thus after he/ she has constructed an equality he/ she picks up from the bag (or requests the random production by the computer) the same number of tiles as the ones he/ she has used for the construction. This requirement does not apply if there are no more tiles in the bag and in this case the player is left with less than 13 tiles.
7. The symbol "-" can be used either as the sign of a negative number or as the symbol of subtraction.
8. The game ends when either

a. There are no other tiles in the bag (or cannot be produced by the computer any more as all available have been used) and the last player used all his tiles, or
b. There are no other tiles in the bag and no player can go out (i.e. can construct any valid equality and use all his tiles)

CARD 2 Rules for calculating the Scoring

ALGEBRASCRABBLE RULES - RULES FOR SCORING

For the scoring in each round

1. Find the total of the score by considering the point value of the tiles used for the construction of the present equality plus the extra points that can be gained from the consideration of the indications on the board in the squares that are used. The latter advantage (getting extra points as it is indicated on the squares of the board) counts only for the first time that a tile is placed on the board.
2. In case all thirteen tiles are used in the present round an extra bonus of 40 points is added for the score in the round.

For the scoring at the end of the game

Further to the total score of each player we have the following two cases depending on how the game ends:

In case (a) (as described in CARD 1) the score of the player that goes out is increased by adding the score values of the tiles with which the other players are left.

In case (b) (as described in CARD 1) the score of each player is decreased by the sum of the score values of the tiles with which he is left.

PLAYING THE GAME

Step 1

Decide on the succession of playing among the players

Step 2

Randomly select 13 tiles for each player out of the 160 available ones

Step 3

The player, whose turn is for playing, constructs an equality and places it on the Board horizontally or vertically

There is a check for the validity of the equality.

In case of a valid equality there is a calculation of the corresponding score for the equality, a check of its correctness and a crediting of the score to the player. The player gets randomly (out of the remaining tiles in the bag) as many tiles as he used, so that he has again 13 tiles.

In case of a non-valid equality the player loses his turn.

Step 4

There is a repetition of Step 3 with the next player and so on until the end of the game

Step 5

Calculate the total score for each player (as described in card 2) and decide on the winner

Additional Exercise

Leaving for the moment aside the algebra scrabble, here we could propose a funny and interesting tool to apply the Computational Thinking to the algebraic calculation.

An excel spreadsheet is really a nice tool to use for experimenting algebraic expressions by using Computational Thinking.

It is always an exercise that combines algebraic skills, logic and mathematical thinking.

a number	6
a number increased by 2	
the number increased by 5	
double the number	
three times the number	
2 less than a number	
3 less than twice a number	
20 more than the number	

https://youtu.be/5QTUL8AKwS8

It is great to see that you know how to use different operations on the number in that cell. Now let's generalize. Pick a variable you like - x, or N, or W - it doesn't matter. What would each of these cells become then? Write those results together with the words in your notebook and show me when you're done.

This is all solidifying into a coherent framework of using spreadsheet and programming tools to reinforce algebra instruction from the start.

EXAMPLE FOR A LESSON PLAN: GRAPH OF A FUNCTION

TOPIC/MATHEMATICAL SUBJECT: Graph of a function, Solving Real Life Problems through approximation methods

APPROACH/ METHOD TO BE USED:

One of the strong assets of mathematics is that they provide models for describing real world problems. One of the approaches in the representation of such real world problems is through functions leading to equations. Such equations can be solved approximately by sketching the graphs of the functions involved. The sketching of such functions can be easily achieved through digital means, like software for sketching graphs. Furthermore, the representation of graphs can provide illustrative approaches for studying and analyzing such functions. Also, it is well mentioning that through real world problems the students are motivated and realize the value of mathematics.

TARGET GROUP: Students from 16-17 years old, in a secondary school

OBJECTIVES:

General Objectives

ObjGen1. To develop skills for problem solving

ObjGen2. To develop motives and positive affective tendencies for mathematics

ObjGen3. To identify/ develop/ create applications of the related concepts and processes in the real world.

ObjGen4. To develop digital skills/ through the use/ exploitation of digital means as help/ support in calculations and representations,

ObjGen5. To exploit the flipped classroom method for supporting the various processes.

Specific Objectives

ObjSpe1. To comprehend the concept of a function and methods of its representations.

ObjSpe2. To sketch the graph of a function and interpret the appearance/ character of some regions or points on it

ObjSpe3. To identify turning points on the graph of a function

ObjSpe4. To relate the graph of function to the approximation of solutions of equations

ObjSpe5. To model a situation mathematically

TOOLS/ EDUCATIONAL TECHNOLOGY

Software for producing graphs, Computers or calculators, the Internet

- Game to graph a line from a function table - https://www.mathgames.com/skill/8.107-graph-a-line-from-a-function-table
- Function Grapher Game - https://www.desmos.com/calculator/xczntamr1z
- Function Grapher and Calculator - https://www.mathsisfun.com/data/function-grapher.php
- Draw Function Graphs - https://rechneronline.de/function-graphs/
- GraphSketch is a free design graphs from a function - https://graphsketch.com/
- Solving real life problems using table, equation and graph - YouTube

  https://www.youtube.com/watch?v=85mx8xQTVDY

- Modeling with linear equations: gym membership & lemonade (video ...
- https://www.khanacademy.org/...equations-functions/...real-world/...

BRIEF DESCRIPTION OF THE PLAN IN THE CONTEXT OF THE DIS-CODE METHODOLOGY

A word problem is given to the students, a couple of weeks earlier than the date of the A word problem is given to the students, a couple of weeks earlier than the date of the classroom discussion of the topic, with a set of hints and the students are asked to collect information and solve the problem at home either alone or by discussion and cooperation with their peers. The problem should create interest for investigation and provide motives for this. It should also be given to the students a set of instructions for identification of the various mathematical terms they have met in previous years and their relations. Then, in the classroom the students present their findings and the whole class proceeds to a systematic consideration of constructing a model for solving the problem. A discussion follows about the various concepts and processes involved as a review/ recapitulation of the strengths and weaknesses of producing functions to describe real world situations and a reflection on its graphical representation and the information we can get out of it.

Reflecting on real life, here we are with some good examples to explain how to use the algorithm design to face daily problems.

Knowing what is an algorithm is a useful instrument to solve a problem. If you have ever baked brownies, you know that first you have to gather ingredients, then measure them, mix them together then prepare the pan, heat the oven and cook them. If you forget the sugar, they do not taste good and you have to start over.

Determining the right steps, following them correctly and completely and learning from mistakes are all part of the process of algorithm design. Algorithms are step by step instructions to get something done or the rules describing how something works. A recipe, or a set of dance steps or a storyboard of an animation are all algorithms.

Although the term "algorithm" might strike fear, the definition of this is only a set of rules for solving a problem in a finite number of steps. It is a set of instructions and may or may not involve mathematics and there are many applications of algorithm in the daily life. A simple, digestible, algorithm that we all use is a recipe. The sequence of steps must be followed in a recipe in a certain order for the final product to taste good.

PLAN FOR WORK

Time	Activities	Methods/ means
2 weeks earlier than the classroom consideration	<u>Give a problem for investigation and for providing a motive</u> For the packaging of milk a factory uses cartons, made of waxed paper, in the form of a rectangular parallelepiped, with square basis. Each carton should contain 0,5 net liters of milk. Given that for the construction of the cartons there is a waste of 20% of paper for bending and sticking, that the thickness of the paper is 0,1 cm and that the liquid should be 0,3 cm below the upper inner surface of the carton, find the dimensions of each carton so that the area of the paper needed is minimum. **<u>Hint 1 (understanding the Problem)</u>** Can we construct a figure that will enable us to develop a plan? Do we have any information about the volume and the area of the figure involved? What are the unknowns involved? **<u>Hint 2 (developing a plan)</u>** Can we simplify the problem? What is the plan for solving the simpler case? How can we extend the plan for the more general case? What are the quantities involved? Can we see any relations between the quantities involved? Do we know any processes for determining the extrema of a function?	Provide written document . Find some software that can help you in graphing functions and practice on using it.

	Hint 3 (Implementing the plan) Have you assigned names to the quantities involved? Can you construct any equations? How do the data of the problem lead to adjustment of the equations? Can you solve the constructed algebraic equations? Do you know any approximation methods for the solution of algebraic equations? Do you see where the extrema of function lie? Can you see what is the slope of the tangent to the graph at such a point? **Hint 4 (Assessing/ investigating the process for the solution)** During the process of solving the problem, do we take care of the different measures involved? Do we accept any of the found values for the extrema? Can we adapt the problem for more complicate cases? Can we adapt the problem so that the factory uses specially ordered sheets of paper and aiming at minimizing the cost? Can we adapt the problem so that the construction of the cartons is such that will enable the minimum cost for buying the paper given that the paper, the factory buys, is of specific dimensions?	
In the classroom on the planned day for the lesson	Provide software for sketching the graph of a function. Provide exercises for this. When do you call a function increasing/ decreasing? Where does a function has local maxima/minima?	Discuss the properties of functions using the graph

	Give a simple situation that can lead to a model that can be represented by a function of one variable. Do you see the power of developing a model through the description by a function	Discussion Use of Excel or other software and possible reference to the related functions
	Provide a set of simple exercises, (e.g. from the textbook) for consolidation and assessment	
	How do we calculate the volume and the surface are area of a parallelepiped? Consider the issue of the given problem initially and review it by constructing a model in the form of a function.	Discussion Presentations of relations
At Home	Ask the children to reconsider the initial problem and try to solve it	
Next day	Ask the pupils to provide their ideas for solving the initial problem.	Discussion Presentation of solutions
	Ask the pupils to create problems using the previous ideas with examples of the real world	

ASSESSMENT/ FEEDBACK

Provide material that will help in realizing the achievement of the objectives

Set exercises from the textbooks that are part of the official curriculum in the school.

Self-assessment

APPENDIX

The solution to the Problem

For the packaging of milk a factory uses cartons, made of waxed paper, in the form of a rectangular parallelepiped, with square basis. Each carton should contain 0,5 net liters of milk. Given that for the construction of the cartons there is a waste of 20% of paper for bending and sticking, that the thickness of the paper is 0,1 cm and that the liquid should be 0,3 cm below the upper inner surface of the carton, find the dimensions of each carton so that the area of the paper needed is minimum.

Area/ Topic/ Subject : Geometry – Measuring solids

Functions – Finding Extrema

Application of mathematics in real life situations

General Ideas for Reflection in order to solve the Problem:

Hint 1 (understanding the Problem)

Can we construct a figure that will enable us to develop a plan?

Do we have any information about the volume and the area of the figure involved?

What are the unknowns involved?

Hint 2 (developing a plan)

Can we simplify the problem?

What is the plan for solving the simpler case?

How can we extent the plan for the more general case?

What are the quantities involved?

Can we see any relations between the quantities involved?

Do we know any processes for determining the extrema of a function?

Hint 3 (Implementing the plan)

Have you assigned names to the quantities involved?

Can you construct any equations?

How do the data of the problem lead to adjustment of the equations?

Can you proceed with differentiation?

Can you solve the constructed algebraic equations?

Do you know any approximation methods for the solution of algebraic equations?

Hint 4 (Assessing/ investigating the process for the solution)

During the process of solving the problem do we take care of the different measures involved?

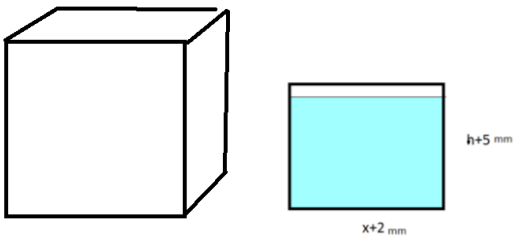
Do we accept any of the found values for the extrema?

Can we adapt the problem for more complicate cases?

Can we adapt the problem so that the factory uses specially ordered sheets of paper and aiming at minimizing the cost?

Can we adapt the problem so that the construction of the cartons is such that will enable the minimum cost for buying the paper given that the paper, the factory buys, is of specific dimensions?

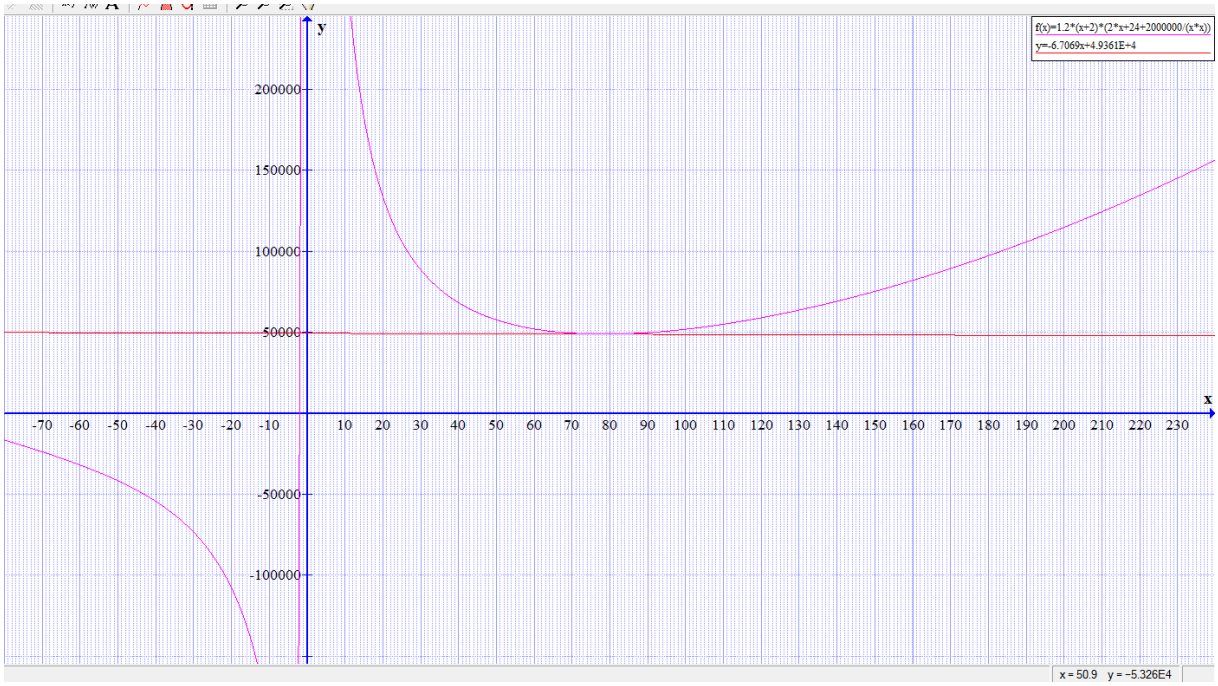
Guided Solution

Steps/Stages	Help/hints	Answer/ solution
Preparatory ideas of the concepts involved	What shape is involved? Can we assign any names-symbols to the quantities involved? What is required?	 Consider a carton in the form of a rectangular parallelepiped and let *x* mm be the length of the inner side of square basis and *h* mm be the height of the liquid in the carton. Then the exterior dimensions of the cartoon should be: $x+2$ mm the side of the square basis $h+5$ mm the height of the parallelepiped Let S denotes the area of the surface of the solid involved and V its volume Let A denotes the area of the total surface area taking into consideration the waste of paper. We are looking for *x and h* so that the volume of the liquid is 0,5 lt and the area A is minimum

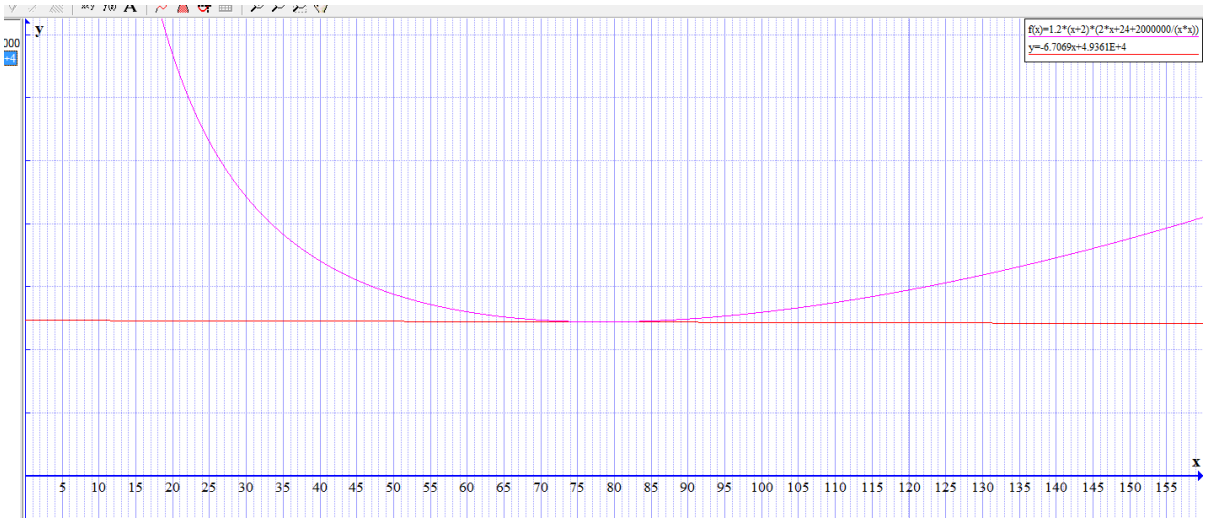
Identification of relations between the concepts	What formulas can we use for finding the volume of the liquid in the carton and how can we determine the area of the carton and the area of the paper required? Can we substitute some of the variables involved and express the area of paper required for a carton in terms of one variable?	The volume of the liquid should satisfy the equation $x2 .h= 500000$ cubic millimeters The exterior area of the cartoon should be $S=2.(x+2)2 +4.(x+2).(h+5)$ square millimeters Since there is a waste of 20% of paper the total required area of cardboard should be $A=1,2\ S=1,2 .[2.(x+2)2 +4.(x+2).(h+5)]$ So $A=1,2\ S=$ $1,2 .[2.(x+2)2 +4.(x+2).(500000x2+5)]$
Determining the extrema of a function	How can we determine the maximum or minimum value of a function and how can we determine the corresponding value of the independent variable? Can we use graphical methods? Can we use differentiation or other methods? How do we solve algebraic equations?	Using an approximation method (for example see the graphs below) we get that A becomes minimum when *x= 78 mm approximately* *Thus h = 82 mm approximately and* *A= 48838 sq mm approximately* ***<u>So the (external) dimensions of the carton are:</u>*** *Side of the square basis: 80 mm approximately* *Height: 87 mm approximately*
Investigation/ assessment of the process and the outcomes	Are the outcomes plausible/ acceptable?	

	Can we extend the problem?	

Sketching the function in the range -80<*x*<210, for the independent variable, to get a first idea of its behaviour



Sketching the function in a more narrow range of values 0<*x*<160, for the independent variable, to get a better idea of its behavior near the points where we expect critical points for the values related to the problem (and hence to realize details)



EXAMPLE FOR A LESSON PLAN: THE PYTHAGOREAN THEOREM

TOPIC/MATHEMATICAL SUBJECT: The Pythagorean Theorem

APPROACH/ METHOD TO BE USED: Exploiting the visual aspects of various concepts involved and producing proofs of the theorem as well as providing real world problems to help the students to understand the value of the theorem. - Applying the Pythagorean theorem to improve a computer program

TARGET GROUP: Students from 14-15 years old, in a secondary school

OBJECTIVES:

General Objectives

GenObj 1. To develop skills for problem solving

GenObj 2. To develop motives and positive affective tendencies for mathematics

GenObj 3. To identify/ develop/ create applications of the related concepts and processes in the real world

GenObj 4. To develop digital skills/ through the use/ exploitation of digital means as help/ support in calculations, visual representations of the concepts, processes involved in handling the theorem

GenObj 5. To exploit the flipped classroom method for supporting the various processes

Specific Objectives

SpeObj 1. To identify the basic constituents of a right angle triangle

SpeObj 2. To state the Pythagorean theorem.

SpeObj 3. To prove, apply/ use the Pythagorean theorem

SpeObj 4. To explain various visual representations of the theorem and exploit them in the proof of the theorem

SpeObj 5. To solve real world problems, using the theorem

SpeObj 6. To state and prove the inverse of the theorem

TOOLS/ EDUCATIONAL TECHNOLOGY

Traditional board and geometrical equipment. Calculators, computers, the Internet.

- Scratch
- Lessons and material for teaching the Pythagorean Theorem - http://www.onlinemathlearning.com/pythagorean-theorem.html
- Bank of lessons, exercises, questions, problems and challenges - https://www.brainingcamp.com/lessons/pythagorean-theorem
- Applying a The Pythagorean Theorem Game in the classroom - http://www.glencoe.com/sec/math/t_resources/gamezone/pdfs/mac3_04/class_ch03.pdf
- Many activities for the Pythagorean Theorem - https://www.pinterest.pt/explore/pythagorean-theorem/?lp=true

BRIEF DESCRIPTION OF THE PLAN IN THE CONTEXT OF THE DIS-CODE METHODOLOGY

As a first step the students are asked to construct at home a puzzle that after proper rearrangements leads to the conclusion that under certain conditions the sum of the areas of two squares is equal to the area of a third square. The students are then asked to specify what these conditions are.

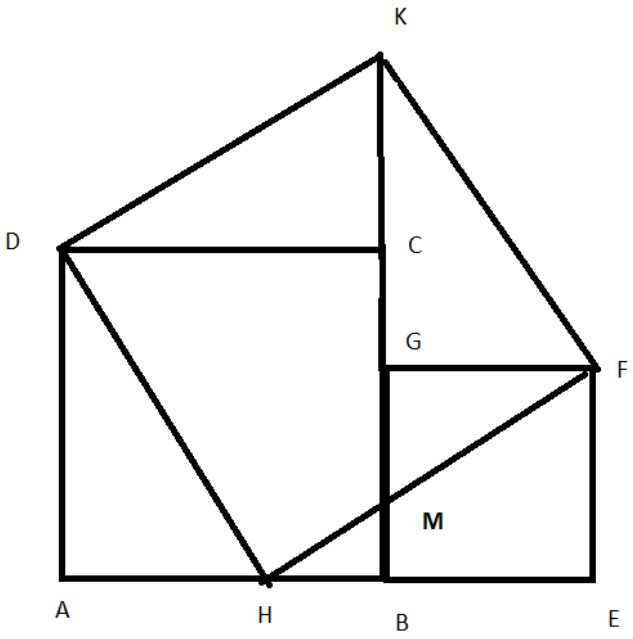
As a second step the students are given a figure and are asked to prove at home certain propositions that can lead to the Pythagorean Theorem.

Furthermore, the students are asked to surf in the Internet about Pythagoras and the historical roots of the theorem

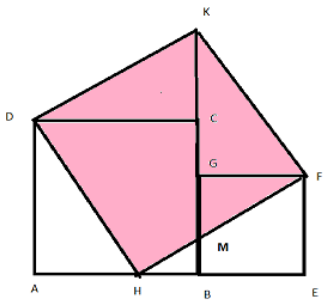
Then in the classroom the students present their findings and the whole class proceeds to a systematic consideration of the Pythagorean theorem and the various concepts and processes involved as a review/ recapitulation of the work they have done at home.

PLAN FOR WORK

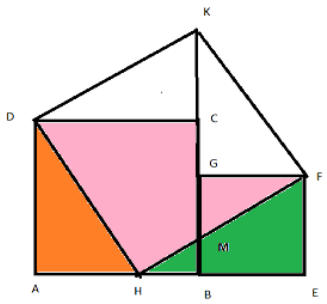
Time	**Activities**	**Methods/ means**
2 weeks earlier than the classroom consideration	STEP 1 **Preparatory work: Aiming to construct a puzzle that can lead to the development of pieces that after proper rearrangement can lead to three squares having the property that the sum of the areas of the two smaller ones is equal to the area of the larger one.** Given the following figure where ABCD is a square of side b=10 cm, BEFG is an adjacent to ABCD square of side c=7cm, H is a point on AB such that EH=b and H lies on line AE between A and E. Draw DH and EH. The point K has been selected so that so that DHFK is a square.	Provide a document with written instructions .



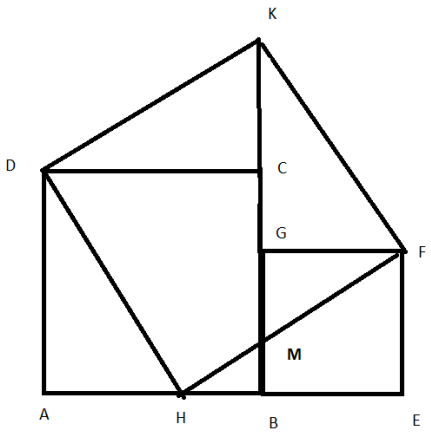
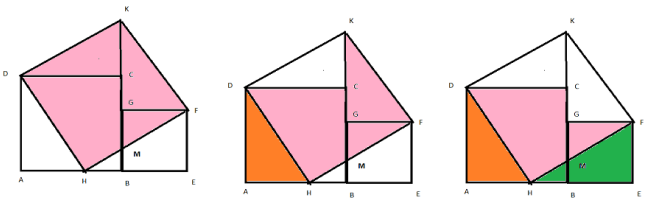
On a piece of cardboard construct the above figure and shade the square DHFK to get the figure:



Using a pair of scissors cut the figure in order to create geometrical pieces that can be used, by rearrangements, to produce a new figure like the following:



What can you deduce for the relations of the areas of the three squares ABCD, BEFG and DHFK ?

1 week earlier than the classroom consideration	**Consider the conclusions that the students have reached and proceed to the** **STEP 2** **Formal approach with hints and instructions that can lead to the proof of the Pythagoras Theorem** Given the following figure where ABCD is a square of side b, BEFG is a square of side c, H is a point on AB such that EH=b and H lies on line AE between A and E. Draw DH and EH. Prove that DH=HF and that DH is perpendicular to HF. Select the point K so that DHFK is a square. Let DH=a. Prove that: $a^2=b^2+c^2$  HINT 1 Can the sequence of the following figures give you a clue?  HINT 2 Prove that triangle DCK is equal to the triangle DAH and that triangle KGF is equal to triangle HEF. (using the known facts about the congruency of triangles) HINT 3 Relate the areas of the squares and the areas of the triangles by considering the pieces that constitute the three squares. Using the areas of squares prove the required relation. (using the formula relating the are of a square with the length of its side.	

In the classroom on the planned day for the lesson	Consider the approaches of the students as they have been developed at home. Discuss the validity and the structure of their presentations Identify difficulties and weaknesses Consider the triangle AHD Ask the students to specify its characteristics, insisting particularly on the angle at A and the lengths of the sides. Ask for the relation between the sides. Explain that this is the Pythagoras theorem Ask for going to the Internet and review the historical origins and other possible events related to it. Generalize by asking to specify : What are the conditions and requirements that lead to the theorem. Ask them to state it and explain it between themselves	Discussion Construction of a right angle triangle and stating the conditions fro the theorem
	Provide examples and exercises from the textbook , or other resources, where the theorem is used for • Practical straightforward calculations • Real world applications of the theorem • In implicit use in approaching other problems/ issues in Geometry or other areas of mathematics (e.g. trigonometry, coordinate geometry and so on)	
At Home	Ask the pupils to create problems using the previous ideas with examples of the real world. Ask the pupils to investigate through the Internet the historical origins and developments that are based on the theorem	
Next day	Present the examples developed/ created by the students Assess	Discussions

PLAN FOR WORK FOR SCRATCH

(after the mathematics lessons and the introduction to Scratch in module 3)

20 min	Example project: Pythagorean theorem https://scratch.mit.edu/projects/176398397/	Review pupils' knowledge about P. theorem
45 min	Example project: Pythagorean theorem 2 + testing https://scratch.mit.edu/projects/176404273/#editor • Create groups • Examine the project in the group (set variable a,set variable b, calculate c on paper, confirm with the program)	Groupwork (groups of 3), one compuer per group, computer and projector for teacher
30 min	Simple operators explanation, testing	Frontal lesson, testing 1:1
90 min	Project: Powers and Roots • Name the projects, create studio, insert projects into studio, fill in project description • Create project to calculate powers • Create project to calculate roots	1:1, computer and projector for teacher
120 min	Create a project similar to: https://scratch.mit.edu/projects/176404273/#editor • The project shows and describes the process of calculations	1:1
45 min	Revision: Coordinates • Teacher reminds students of coordinates, shows how to use them in scratch • Exercise: drawing or writing custom designs using the scratch pen tool and coordinates of the turning points	frontal lesson, exercise 1:1
90 min	Distance along an axis: Improving the maze game to calculate and display score – how far did the player get from the left side of the screen (start) to the right (end of the maze) • Exploration with computer, paper+pen • Testing hypotheses • Formulating solutions • Implementing and testing solutions • Improvements: continuous display of the score, using extra variable for calculated distance, using custom block to calculate distance	1:1, groupwork
90 min	Actual distance to the end: Further improving the maze game, calculate the actual distance, not only along the axis	1:1, groupwork

	• Building on the previous solution, exploration with computer, paper+pen • Testing hypotheses • Formulating solutions • Implementing and testing solutions Improvements using distance calculation: avoiding dangerous places in the maze, dynamically decorate the maze Other simple game ides: Blind maps (giving score based on precision of guessed places), metal detector (beeping proportionately to the distance from hidden metal) More advanced idea: generate all Pythagorean triangles up to a limit, and do it efficiently	

ASSESSMENT/ FEEDBACK

Provide material that will help in realizing the achievement of the objectives: multiple choice test covering both cognitive and affective domain issues

Self-assessment

- Quiz about the Pythagorean Theorem - https://www.mathgames.com/skill/8.57-pythagorean-theorem-find-the-hypotenuse
- Pythagorean Theorem - Quizzes - Printables - Games - Worked Examples - For Children - http://www.algebra4children.com/topics_pythagorean_theorem.html

Talking about the real life, here we might propose some reflections on the use of abstraction, which is one of the most important component of the approaching to the theorems.

In the same way that the theory is useful to understand how to solve a given problem, abstraction, one of the steps of computational thinking, can help address real-life problems.

Abstraction is identifying and extracting relevant information to define main ideas.

Abstraction lets one object stands for many and allows us to deal with complexity and scale.

Using what you learned by recognizing patterns, relevant variables can be identified, grouped and generalized.

So that they define the main ideas of a problem.

One of the components of the abstraction is the variable.

A variable is a name that can be associated with a value.

Variables have changing that can be represented by a number, letter, word, blank or image.

Often the value of one variable will determine, or be dependent, upon another.

Related to abstraction is the pattern generalization.

It is creating models, rules, or theories of observed patterns to test predicted outcomes.

It is figuring out the right relationship between the abstracted variables to accurately represent the problem.

Regarding our matter, most of mathematics involves abstraction. Even something as simple as a triangle is an abstraction of points, lines and angles.
Regarding other matters, when we learn a language we learn about how the different parts of speech come together to form a sentence.
In English, for example, the grammar is based on a simple structure

SUBJECT (person or thing) +

ACTION / OCCURENCE / STATE OF BEING

+ OBJECT (person or thing)

OR

NOUN + VERB + OBJECT (person or thing)

MODULE 3: INTRODUCTION TO CODING IN SCRATCH

DESCRIPTION

This module serves as an introduction to coding in Scratch. Coding is used at a final stage of all mathematical modules. Therefore, after or along the described Maths activities, students are introduced to Scratch using this module. It does not need to be repeated, in the case when the same students take two or more modules. It is also fairly independent on the Maths part and may be done simultaneously or even before the Maths lessons.

TARGET: Students from 12-15 years old

DURATION: This particular lesson is expected to be covered in 4x45min

EFFORT FOR THE STUDENTS: Approximately 8 hours

SYLLABUS

- Introduction to Scratch
- Main Scratch blocks
- Basic components
- Characters and backgrounds
- Scratch project

LEARNING GOALS

- their way around the Scratch environment
- various kinds of Scratch blocks
- basic components of an interactive game project
- run Scratch in their browser
- create a user account in Scratch
- use the basic features of Scratch
- create and edit characters and backgrounds
- create, edit and share Scratch projects
- use the basic block types and combine them into meaningful programs

METHODOLOGY

Pupils first explore the Scratch environment and then experiment to figure out the function of the most basic features and Scratch blocks. This can be done in a flipped mode, using provided online videos.

They continue to explore some very simple projects. That prepares them to build one project themselves, at first in a guided manner. They follow the teacher step by step to complete a simple maze game. This concludes the introduction to coding and to Scratch.

RESOURCES

Shared Scratch projects: https://scratch.mit.edu/explore/projects/all
Scratch Basics: https://www.youtube.com/watch?v=0pxaFzRtx7k
Scratch Video Tutorials: https://scratch.mit.edu/help/videos/

BIBLIOGRAPHY

RESNICK, Mitchel. *Lifelong Kindergarten: Cultivating Creativity Through Projects, Passion, Peers, and Play*. MIT Press, 2017.
BAGGE, Phil. *How to Teach Primary Programming Using Scratch: Teacher's Handbook.* University of Buckingham Press, 2015.

EXAMPLE FOR A LESSON PLAN: SCRATCH

TOPIC: Introduction to Coding in Scratch

APPROACH/METHOD TO BE USED: Explore the environment and features of Scratch, then apply the knowledge and develop a simple game

TARGET GROUP: Students from 12-15 years old

OBJECTIVES:
Pupils will be able to:
Obj1. work in the Scratch environment, use its basic features and manage projects,
Obj2. use the basic block types and combine them into meaningful programs,
Obj3. finish an interactive project based on a template project

TOOLS

- Computers for pupils outside classes (to watch online video and work in Scratch)
- Computer for each pupil in class (Scratch, headphones)
- Projector/screen in the classroom

BRIEF DESCRIPTION OF THE PLAN IN THE CONTEXT OF THE DIS-CODE METHODOLOGY

After or along the described maths activities, students are introduced to Scratch. They learn to use the environment and then experiment to figure out the function of the most basic features and Scratch blocks. They continue to explore some very simple projects. That prepares them to build one project themselves, at first in a guided manner. They follow the teacher step by step to complete a simple maze game. This concludes the introduction to Scratch, which is equivalent in all 4 modules. It does not need to be repeated, in the case when the same students take two or more modules. It is also

fairly independent on the maths part and may be done simultaneously or even before the maths lessons.

PLAN FOR WORK

Time	Activities	Methods/means
45 min	**Introduction to Scratch** • What is Scratch • Finding inspiration in the online environment • How to create a new project • Working environment description • Inserting a new character • Inserting new background **Control features testing** – link for pupils: https://scratch.mit.edu/projects/76585610/ • Each pupil tests individual control features at his/her own pace	frontal lesson, 1:1 lesson, PC+headphones for every pupil, PC for the teacher, projector/screen
15 min	**Registration into the online environment** – Video (homework: watch video, create account) • Registration procedure • Profile editing • Project • Studio	
45 min	First projects • Naming projects, creating studio, inserting projects into studio, project description • Inserting character • Inserting background • Movement tab https://scratch.mit.edu/projects/79684670/ https://scratch.mit.edu/projects/79684436/	1:1 lesson – PC for every pupil, PC for the teacher, projector/screen
90 min	Program your own game • https://scratch.mit.edu/projects/131921602/ • Drawing the maze in the background • Choosing character, changing size • Conditions: explanation • Keyboard controls • Bouncing from walls • Selecting and resizing character • Bonus points, additional characters, size changes, locations • Variables: explanation • Using variables for timing and score • Messages • Sharing projects	1:1 lesson – PC for every pupil, PC for the teacher, projector/screen

CONCLUSIONS

In this document we have described a training plan which gives a detailed explanation to teachers how to use code to teach Maths in their classrooms and how to improve their digital literacy.

It was suggested a training structure that can be followed by teachers, as well as some lesson plans which can be used, adapted, modified or personalized by teachers to teach their students in their own countries, with the same main goal of improving the motivation of the students and their knowledge about Maths, Coding, Digital Literacy and transversal skills.

We hope they can apply this training plan not only inside this experience of this project, but also in other classrooms, sharing this experience with other students, other levels and sharing this lesson plans with other teachers in other schools of other countries.