Deliverable Report

Extending Design Thinking with Emerging Digital Technologies

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(Integration of emerging new technologies into education and training)

Deliverable 3.1
Report on Educational Activities for Students (Final Report)

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Exten.(D.T.)^2 identifier	Deliverable 3.1: Report on the Educational Activities for Students (Final Report)
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1 Abbreviations

AI	Artificial Intelligence
AR	Augmented Reality
ChoiCo	Choices with Consequences
DT	Design Thinking
Exten.(D.T.)^2	Extended Squared
GearsBot	General Educational Autonomous Robotics Simulator (virtual robotics software)
LNU	Linnaeus University
MaLT2	Machine Lab Turtleworld 2
NKUA	National and Kapodistrian University of Athens
NTNU	Norwegian University of Science and Technology
OU	The Open University
SIMPLE	SIMPLE - SME
SorBET	Sorting Based on Educational Technology
TCD	Trinity College Dublin
UCL	University College London
UGent	Ghent University
Virtual Robotics	Use of robotics in a digital environment
WP	Work Package

2 List of Figures

3 Summary

An Initial Report with the same title, covering eductional activities and supporting material for students was submitted in M9. This is the Final Report and presents how teachers taking part in the Exten.(D.T.)² project worked with the project team and co-designed a set of educational resources for supporting school interventions based on the Design Thinking (DT) methodology and the following extended technologies: a) a tool for playing and designing simulation games dealing with socio-scientific issues, *ChoiCo*, b) a tool for playing and designing classification games, *SorBET*, c) the programmable 3D modeller, *MaLT2*, d) an online research platform, *nQuire for students*, that enables students and teachers to design, manage, pilot and launch studies, and e) *Virtual Robotics activities* with a virtual robotic platform (GearsBot).

4 Introduction

4.1 Objectives

This deliverable relates to "Task 3.1. Co-design and development of educational activities using project technologies" of Work Package 3 (WP3), the aim of which is to co-design with teachers a number of educational resources for supporting school interventions (see WP5). Specific objectives of this deliverable are to: a) detail the process of co-designing educational resources with participating teachers across different countries, and b) present the educational activities teachers created using project technologies for use in school implementations. To address these objectives, we collected information from project partners that created and implemented activity plans with teachers. These partners are LNU, NKUA, NTNU, the OU, UGent and TCD.

Below we present an overview of: a) project technologies that teachers used in their DT activities in their classrooms. For this updated Final Report, the project technologies have been extended with additional functionalities in the second year of the project and these are highlighted in the text, and b) video tutorials developed to support teachers' and students' engagement with project technologies.

4.2 ChoiCo

ChoiCo (http://etl.ppp.uoa.gr/choico/) is an educational digital tool that provides opportunities for teachers and students to play and/or modify choice-driven simulation games. With ChoiCo, students can become sensitive to and grapple with wicked problems presented by games. As game players, students are asked to make choices on a map setting, each of which has certain consequences. The aim is to remain in the game for as long as possible. As game designers, students can decide on and design the game components such as the choices, the fields, the consequences and the game rules, and create their own game version. The game has been extended to include Google maps, geolocation of player's location, and live traffic data which affect the game rules (see Figure 1). These features can be used to pin choices on.

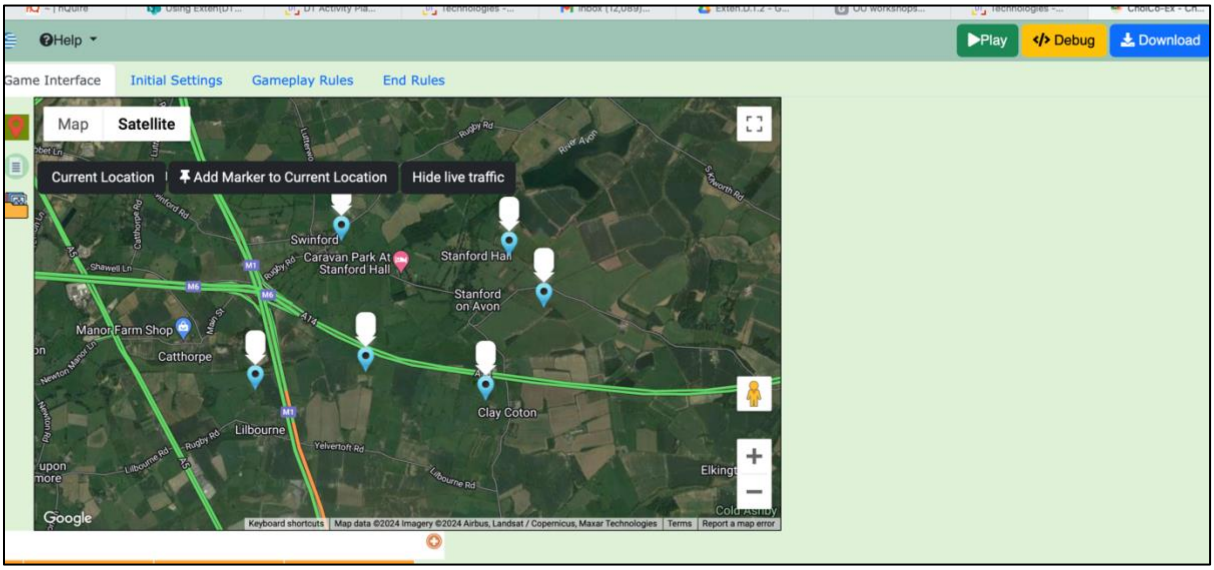


Figure 1: A ChoiCo game with Google map and live traffic functionalities

4.3 SorBET

SorBET (http://etl.ppp.uoa.gr/sorbet/) is a digital tool in which students can design, modify, share and play Tetris-like classification games. Gameplay is about quick decision making related to 'pushing' falling objects to the category they belong to. In order to do so, players need to identify the characteristics of each object and match them with those of their respective category. SorBET allows the design and modification of the game elements such as density, speed, rules, object and category definitions, with block-based programming and database affordances. In the second year of the project, SorBET has been extended with gesture recognition functionalities (see Figure 2). Students can move the falling items sideways by moving their hands controlled by the camera. Two students can play the game simultaneously, using one hand each to sort out falling objects on the screen. This latter activity has the potential to promote student collaboration, negotiation and development of decision-making skills.

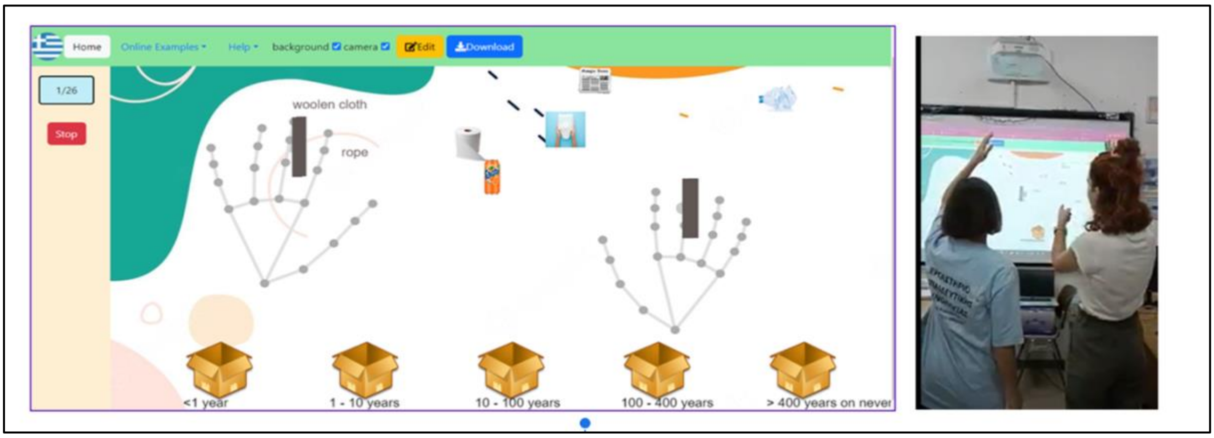


Figure 2: Gesture recognition functionality in SorBET

4.4 MaLT2

With MaLT2 (http://etl.ppp.uoa.gr/malt2/) students create and share animated 2D and 3D figural models with text-based programming and dynamic manipulation. The models can vary from simple cubes to complex DNA models, jewels and fractal trees and anything one can imagine. Ideas and concepts from mathematics, engineering, art and computer science are seamlessly combined in a creative and collaborative process of experimentation, tinkering and self-expression. In Year 2, MALT2 has been extended to connect with 3D printing, allowing for artefacts designed in MaLT2 to be printed out in 3D shapes (see Figure 3).

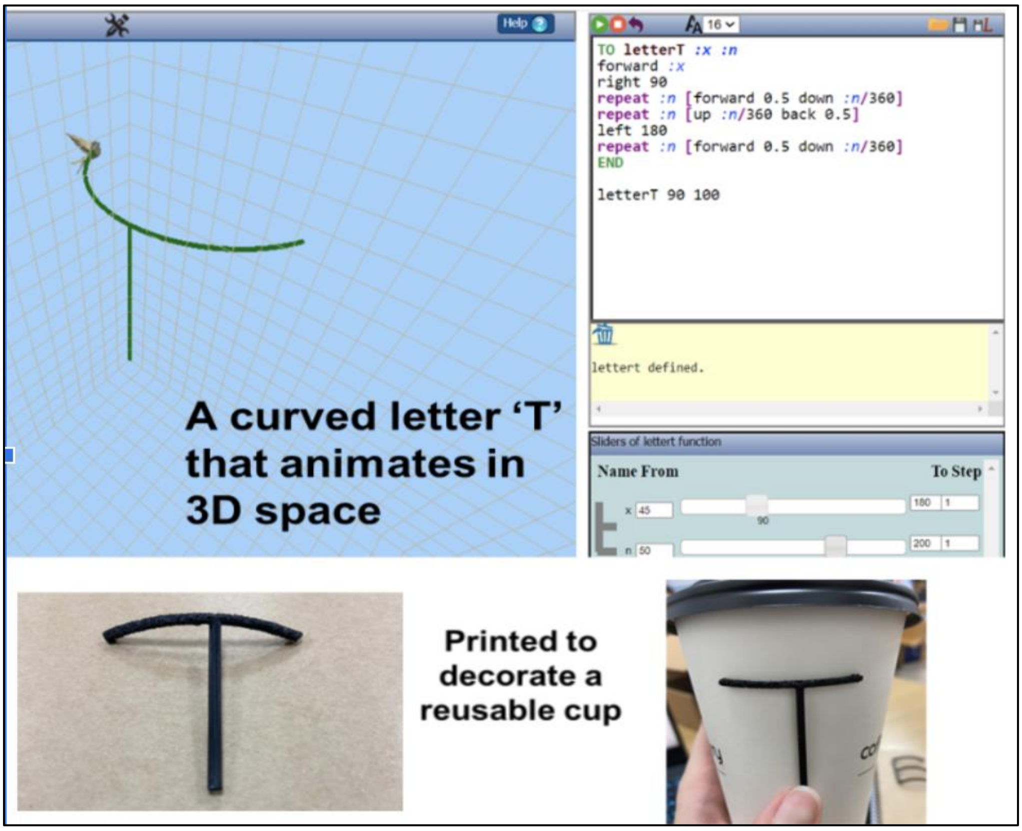


Figure 3: 3D printed Letter T designed and printed using MaLT2 to decorate a coffee cup

4.5 nQuire for students

nQuire for students (https://learn.nquire.org.uk/signin) is an online platform that teachers can use to create a study for their students to take part in or ask their students to create their own studies. It enables students and teachers to design, manage, pilot and launch studies ("missions"). Data can be collected from other students and teachers who are registered with the platform within a single school or classroom. nQuire for students presents a range of different types of questions that can help with data collection in the form of text, numbers, images and sensor-captured data such as light and sound data. The users can also view responses on a map, provide their participants with personalised feedback or enable "data visualisations" that are summary graphs showing what data look like while these are collected.

Data visualisations can keep participants engaged and also enable study authors to share early findings with them.

In Year 2 (see Figures 4 and 5): a) a set of prompting questions have been added to help students and teachers reflect on the mission design before and when this is piloted, b) the filtering functionality is restricted to showing studies from a single school (instead of across schools), to safeguard anonymity and avoid any misuse of the platform by registered users that may belong to another school, and c) a first version of a learning analytics dashboard has been produced showing information such as number of studies a student has drafted and launched, number of contributions, and status of missions.

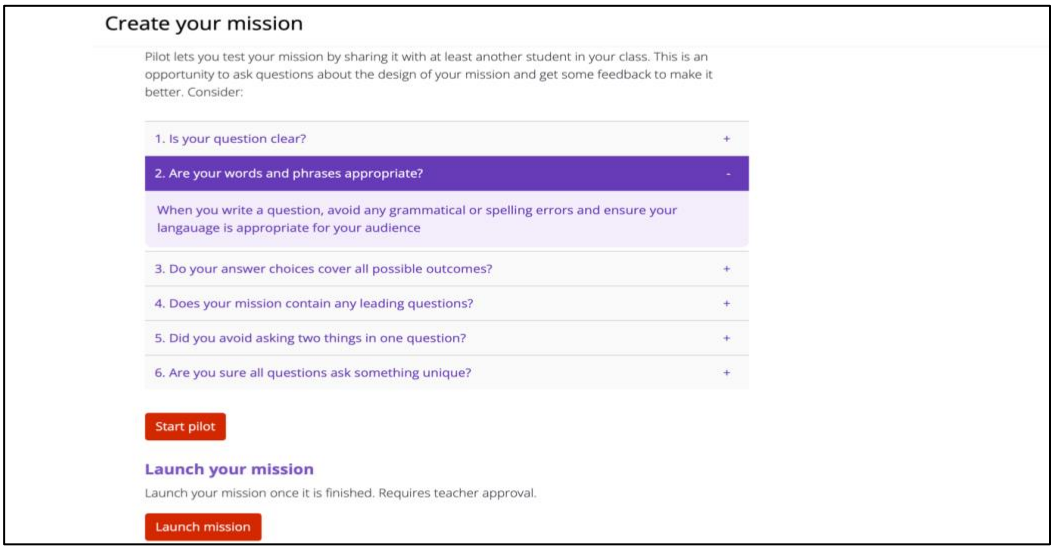


Figure 4: Prompting questions to guide users in creating a mission on nQuire for Students

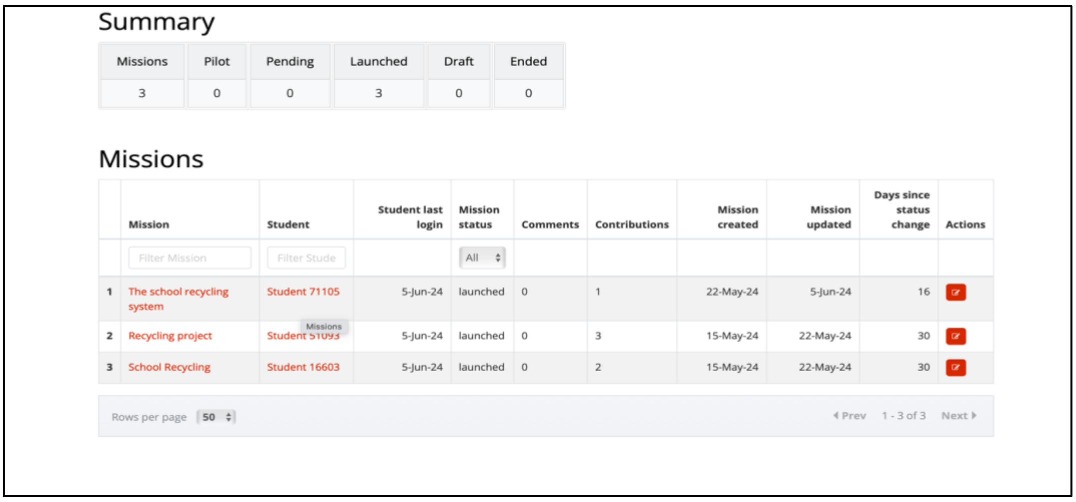


Figure 5: Learning analytics information on nQuire for Students

4.6 Virtual Robotics: GearsBot

A specific virtual robotics software has been chosen by the research team for use in the project. This is GearsBot which is an acronym for Generic Educational Autonomous Robotics Simulator (https://gears.aposteriori.com.sg/). It has been fully integrated within the ExtenDT2 Platform (http://extendt2.com/) and is considered as one of the project technologies in Year 2. This is an open-source robotics simulator written in JavaScript and Python. The platform has three tabs: two for programming and one for simulation of the robot (see Figure 6). One of the programming tabs has a simple form of programming, namely block-coding that users can drag-and-drop blocks. The other tab requires the users to write their code in Python. In Year 2 of the project, GearsBot has been extended to export user data for use in an authorable learning analytics dashboard the project is designing.

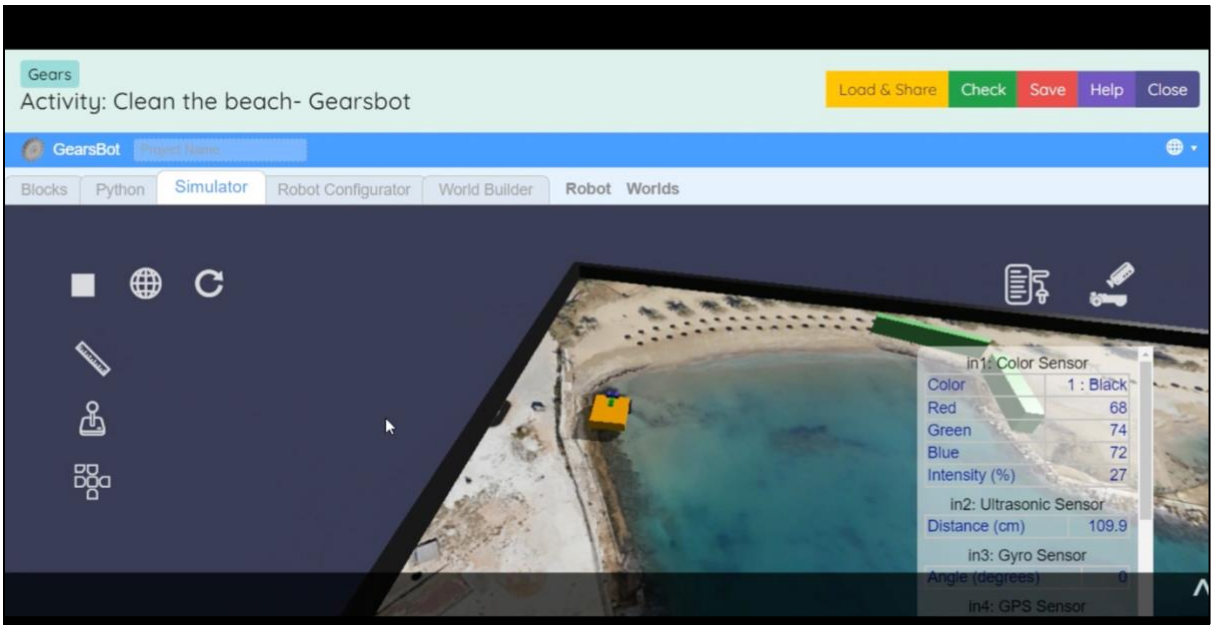


Figure 6: Running a simulator in GearsBot

More information about the project technologies can be found in D4.2 and D4.3. In the next Section, we present the activity plans that have been co-designed by teachers and researchers and were implemented in classrooms in Sweden, Greece, the UK, Norway, Belgium and the Republic of Ireland. The detailed presentation and analysis of template activity plans across countries is part of WP5 Deliverables (therefore this analysis has been excluded from this Deliverable).

5 Co-design of educational activities using project technologies

To co-design educational activities with participating teachers, we devised and used two tools: a revised DT activity plan template (see D5.1) and a structured plan to conduct participatory workshops with teachers (see D3.1 Initial Report - Month 9, May 2023). We placed emphasis on including user-centred design approaches in order to ensure that teacher perspectives, insights, and needs can be considered and guide the design of project artefacts. These approaches helped to structure interaction with teachers, provided consistency in reporting across countries and between different school implementations and assisted the process of data collection and analysis.

5.1 Co-design tools

A revised Design Thinking **Activity Plan Template** (see Figure 7) initially developed by NKUA for WP5, guided the process of co-designing learning activities with teachers. It provided the team with a structure to follow when designing activities using project technologies.

DESIGN THINKING ACTIVITY PLAN TEMPLATE	YEAR 2

1. BASIC INFORMATION

PROJECT TITLE:

Title of the Design Thinking (DT) Project

AUTHOR(S):

Name(s) of teacher (s), designer(s), researcher(s) who created the Activity Plan

ISSUE:

Briefly Describe the **problem** or the **topic** that this DT project seeks to solve in 1-2 sentences.

E.g. Metal mining for jewellery production purposes has a hugely detrimental impact on the planet. In times critical for environmental sustainability, it is important for the industry to develop more sustainable methods for jewellery production.

FINAL STUDENT PRODUCTION:

What is the expected final artifact that will be produced by the students using emerging technologies throughout the DT project?

e.g.1 a 3D model of a jewel

e.g.2 a GIS simulation game for sustainable transportation in the city

TECHNOLOGIES TO BE USED:

Select the ExtenDT2 technologies that will be used by students during the DT Project

☐ MaLT2 ☐ ChoiCo ☐ SorBET ☐ VRobotics ☐ NQuire

2. FOCUS, SET UP & REQUIREMENTS OF THE ACTIVITY

Figure 7: A snapshot of the revised activity plan

The DT activity plan, devised by NKUA researchers, requests information related to, for example, classroom set-up, learning objectives, prior student knowledge, teaching material, activity mapping to DT stages. It includes 5 steps:

- Step 1. Empathise and understand
- Step 2. Define and ideate
- Step 3. Rapid prototyping and iteration
- Step 4. Sharing and feedback
- Step 5. Respond and deliver

These steps map to the **Exten. (D.T.)² Digital Design Thinking model** (see Figure 8) produced to support teachers and students in the process of design.

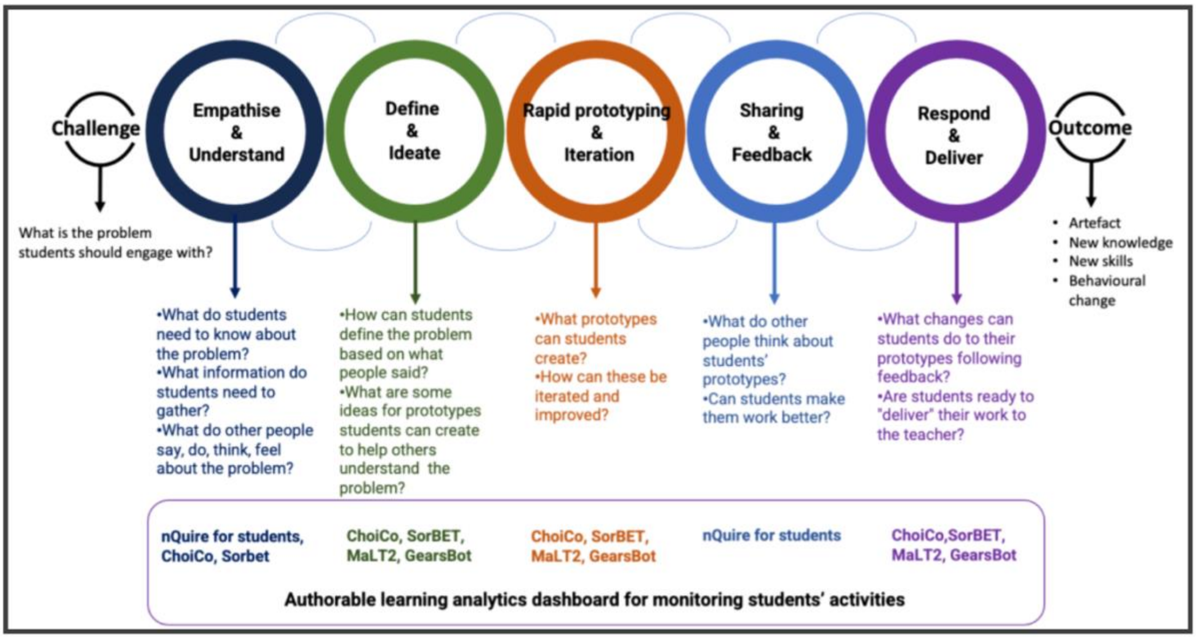


Figure 8: The new Exten(D.T.)² Digital Design Thinking model developed in Year 2

An online version of the template activity plan is also updated on the ExtenDT2 platform (http://extendt2.com/) and the nQuire platform (https://nquire.org.uk/mission/extendt2-activity-plan-for-teachers/data). The purpose is for teachers to create an activity plan and make it public for other teachers to use and give feedback as needed.

5.2 Co-design workshop with teachers

Material for **a three-hour online workshop** with teachers has been produced which incorporated an introduction to design thinking, project technologies, and activity plans for DT implementation. During the workshops teachers were given opportunities for reflection on how technologies can be integrated to implement design thinking in their classrooms. So far 17 workshops have been delivered by partners based in Sweden, Greece, the UK, Norway, Belgium and the Republic of Ireland. The learning outcomes of the workshop were:

- To explain to students what DT is and why it is useful (model, vocabulary, examples)
- To explain about 6 innovative digital technologies which can be used in DT projects
- To identify the added value of using digital technologies to design DT activities
- To identify a problem relevant to students' needs that can be solved using DT and technologies
- To develop an activity plan teachers can implement with their students

The workshops became the starting point for teachers to come up with an activity plan to implement DT activity in their classrooms.

Teachers and researchers in Sweden, Greece, the UK, Belgium, Norway and the Republic of Ireland collaboratively developed 19 activity plans. The classroom activities implemented in Year 2 are reported in detail in D5.3. A representative example of one of the activity plans from each location is provided below.

5.1.1 LNU (Sweden)

Number of activity plans:	1 (implemented in 3 different classrooms)	
Activities using project technologies	**Technologies**	**Topics**
	ChoiCo for conceptualizing, designing and creating a computer game	Sustainability Environmental science & awareness Computational Thinking (CT) Socio-scientific issues in K12 education

Researchers at LNU in Sweden, in collaboration with teachers from Thoren Framtid Elementary, designed an eight-session school activity. The primary goal was to identify, explore, and discuss with students the ongoing issue of the declining bee population in various regions around the world.

A total of 76 eighth-grade students from three different classes (all from the same school) participated in this specific activity, which was conducted over eight sessions, totaling nine hours. At the start of each session, students received a brief introduction to the main topic and were introduced to the fundamentals of DT. They were then tasked with applying DT methods to design, implement, and test a computer game using ChoiCo.

The activity plan related to Save the Bees (Figure 9): The game's objective was to help users discover solutions to save the bees and support the pollination process. During stage 1 of the DT process, students, guided by their teacher and two researchers, explore the concept of empathy, investigating different resources and asking insightful questions related to the declining bee population. At stage 2, each group of students played an existing ChoiCo game to become familiar with the technology's functionalities, define critical parameters, and select the various components of the game interface they would use during development. In stage 3, students collaboratively designed a different game concept using ChoiCo, focusing on the themes of pollination and the life cycle of bees. They thoroughly tested their games by playing them, fine-tuning the behaviors, and determining the outcomes the game should generate. At stage 4, students presented their completed creations to their peers, who then engaged in a critical analysis by testing the games and providing constructive feedback. These games were intended to offer potential solutions to the bee-related problem, and through iterative user-testing of each other's designs, students progressively refined their solutions.

DESIGN THINKING ACTIVITY PLAN TEMPLATE

SCHOOL INTERVENTION AT THOREN FRAMTID GRUNDSKOLA, VÄXJÖ, SWEDEN. (SPRING TERM 2024)

1. BASIC INFORMATION

PROJECT TITLE:

Title of the Design Thinking project: "Save the bees"

AUTHOR(S):

Katrin Lindwall & Marcelo Milrad

ISSUE:

The main problem to be addressed in this activity is the fact that the population of bees around the world is starting to gradually decrease and that will cause problems with plant pollination. How can students design a possible solution by using the principles of Design Thinking and the technologies developed in the project. Students must design a simple simulation game that could offer a solution to this problem by thinking of possible factors of our modern lifestyle that may be endangering the bees.

FINAL STUDENT PRODUCTION:

Students (in groups) are to design, implement and user-test a computer game that simulates the consequences of different actions made in a particular chosen environment and that could affect the bees. These games must be designed with the goal of ensuring the survival of bees.

TECHNOLOGIES TO BE USED:

- Choico
- Wooclap (collecting student feedback in real time)
- Google Docs

☐ MaLT2 X ChoiCo ☐ SorBET ☐ VRobotics ☐ NQuire

2. FOCUS, SET UP & REQUIREMENTS OF THE ACTIVITY

Figure 9: A snapshot of the sample activity plan co-designed by a teacher and researchers in Sweden

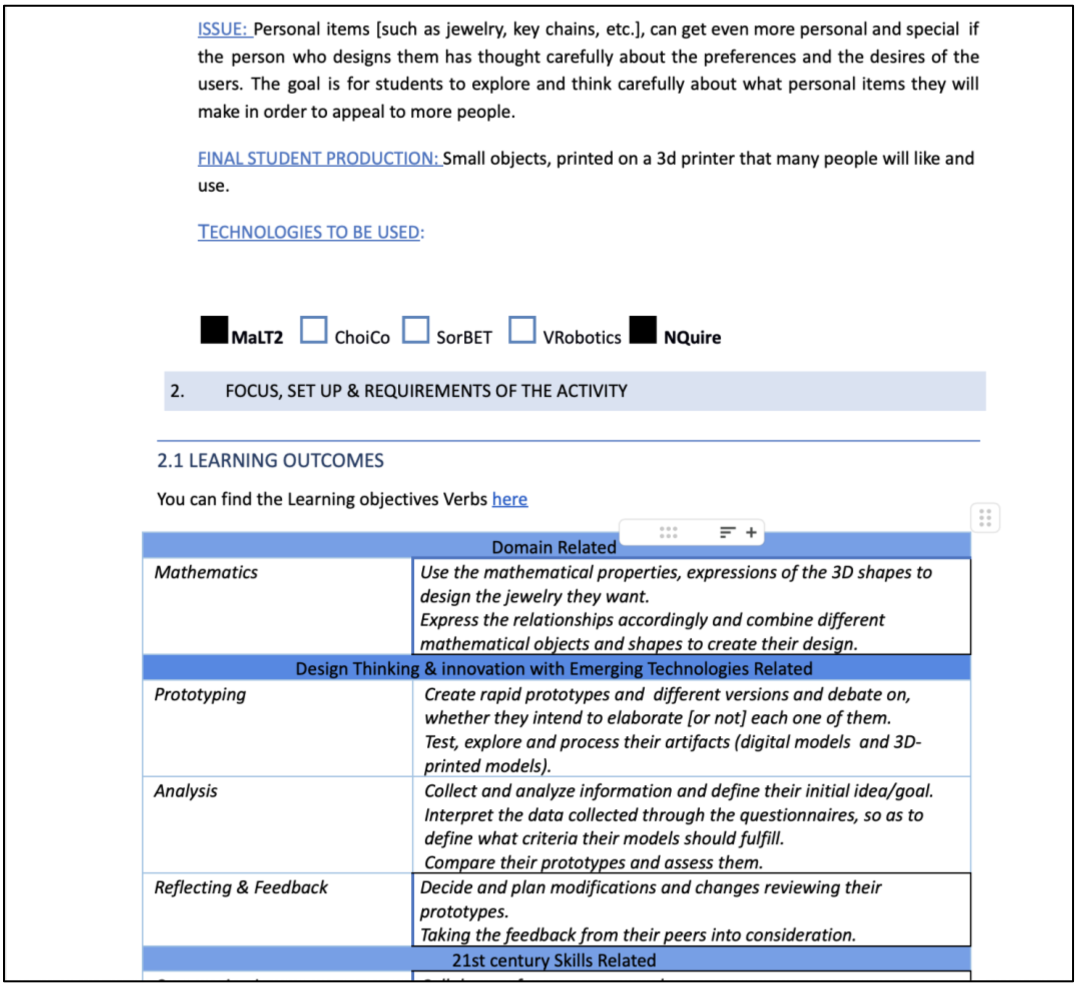
5.1.2 NKUA (Greece)

Number of activity plans:	8	
Activities using project technologies	**Technologies**	**Topics**
	MaLT2 and nQuire for students	Jewellery
	SorBET and nQuire for students	Cyber Security
	ChoiCo	Sustainable Travelling
	ChoiCo	Entrepreneurship
	GearsBot	Sea Cleaning
	MaLT2 and nQuire for students	Personalised items
	MaLT2 and nQuire for students	Making puzzles
	ChoiCo	Digital games for commercial purpose

Teachers in Greece and NKUA researchers co-created eight activity plans to be implemented in after-school and in-school sessions in primary schools, junior high schools and vocational high schools. The topics they covered were personalized jewellery, cyber security, sustainable travelling, entrepreneurship, sea cleaning, printable personalised items, making 3D printable puzzles and developed a digital game for commercial purposes. The technologies teachers used were MaLT2, SorBET, ChoiCo, GearsBot and nQuire for students. They co-designed activity plans to be implemented for 8-10 hours. One of the activity plans related to personalised jewellery is detailed below.

The activity plan related to personalized jewellery (Figure 10) lists the following learning objectives: using mathematical properties and expressions of 3D shapes to design jewellery students want, expressing relationships accordingly and combining different mathematical objects and shapes to create their design, creating rapid prototypes and different versions and debating on whether they intend to elaborate [or not] on each one of them, testing, exploring and processing their artefacts (digital models and 3D- printed models), collecting and analysing information and defining their initial idea/goal, interpreting the data collected through the questionnaires so as to define what criteria their models should fulfil and comparing their prototypes and assessing them, deciding and planning modifications, and changing and reviewing the prototypes.

At the 'empathise and understand' stage, students discuss the issue of constructing jewellery with their teacher and then with each other in their groups. They explore what kind of jewellery they want to make and what to do with it later (e.g., sell it in a bazaar to collect money for a school excursion in 2 months). In the second stage of DT, to define what jewellery they will make, each group takes time to discuss the answers collected through the nQuire questionnaires and decide what findings could be helpful and useful and come up with some first ideas and generate a prototype for their 3D object in MaLT2. In stage 3, students in groups construct their prototypes in MaLT2, based on their choices. Then they exchange prototypes, by showing to other groups what they have designed. This is a first, small, cycle of feedback so that each group decides on which prototype they are going to print. They debate with other students about the extent to which these prototypes are close to what they had agreed on, during the 'ideate' phase, and how close they are to the needs and desires expressed through the questionnaires. In the meantime (for a week), the constructions of the students can be printed.



ISSUE: Personal items [such as jewelry, key chains, etc.], can get even more personal and special if the person who designs them has thought carefully about the preferences and the desires of the users. The goal is for students to explore and think carefully about what personal items they will make in order to appeal to more people.

FINAL STUDENT PRODUCTION: Small objects, printed on a 3d printer that many people will like and use.

TECHNOLOGIES TO BE USED:

■ **MaLT2** ☐ ChoiCo ☐ SorBET ☐ VRobotics ■ **NQuire**

2. FOCUS, SET UP & REQUIREMENTS OF THE ACTIVITY

2.1 LEARNING OUTCOMES

You can find the Learning objectives Verbs here

Domain Related	
Mathematics	*Use the mathematical properties, expressions of the 3D shapes to design the jewelry they want.* *Express the relationships accordingly and combine different mathematical objects and shapes to create their design.*
Design Thinking & innovation with Emerging Technologies Related	
Prototyping	*Create rapid prototypes and different versions and debate on, whether they intend to elaborate [or not] each one of them.* *Test, explore and process their artifacts (digital models and 3D-printed models).*
Analysis	*Collect and analyze information and define their initial idea/goal.* *Interpret the data collected through the questionnaires, so as to define what criteria their models should fulfill.* *Compare their prototypes and assess them.*
Reflecting & Feedback	*Decide and plan modifications and changes reviewing their prototypes.* *Taking the feedback from their peers into consideration.*
21st century Skills Related	

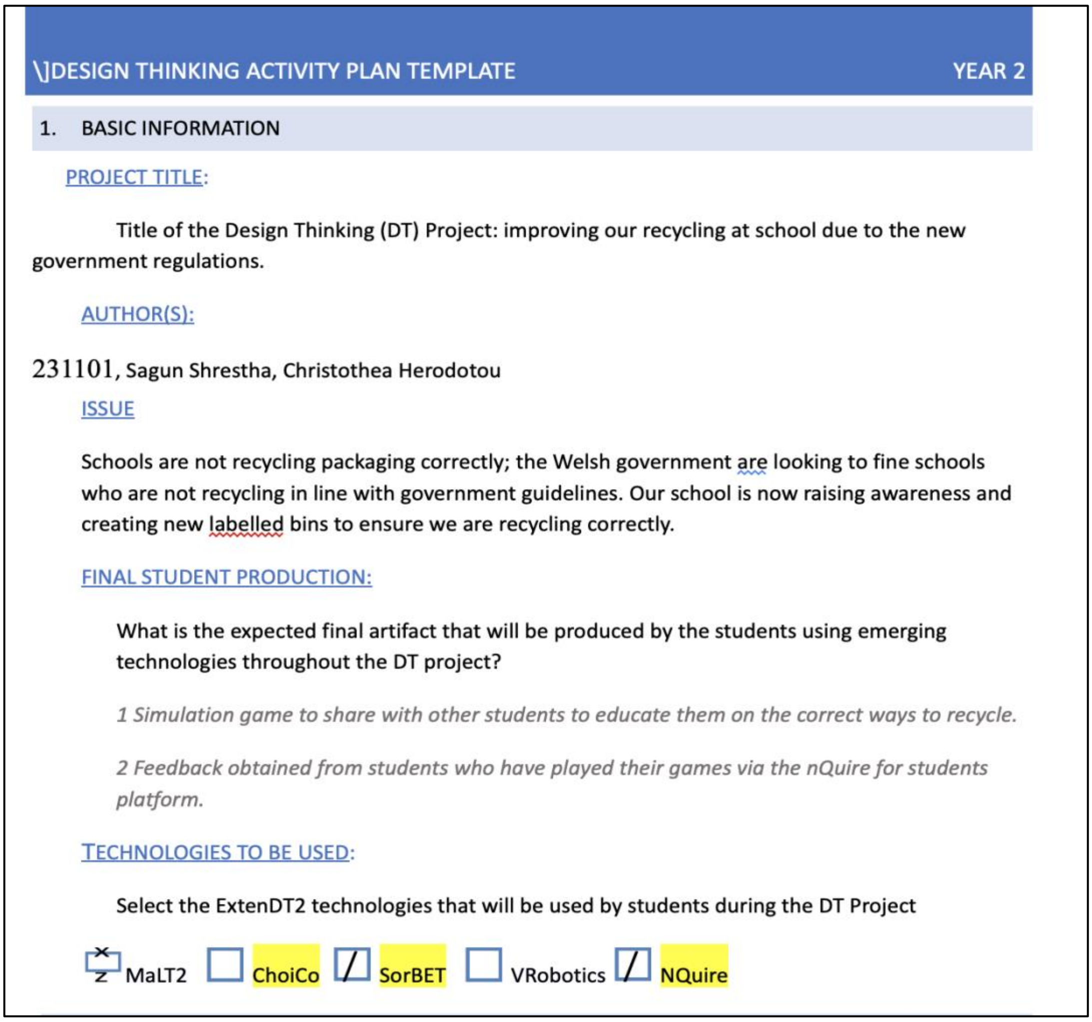
Figure 10: A snapshot of the sample activity plan co-designed by a teacher and researchers in Greece

In stage 4, students have shown their (digital) prototypes through nQuire for students to their friends in order to get feedback. They briefly present them (the digital and the printed ones) in the classroom too, so as to communicate their design and ideas. Each printed jewellery is placed on a desk, and other groups can approach and touch it, see it, ask questions and discuss it with the constructors. They can also manipulate the digital artefact of each group on the platform and explore its characteristics. The groups exchange feedback on their work. They make decisions on possible modifications and changes to their models in order to produce their final artefact. In stage 5, they try to apply modifications to the logo code. They discuss every group's idea and achievements. They decide which will be the final object to be printed in the future.

5.1.3 OU (UK)

Number of activity plans:	2	
Activities using project technologies	**Technologies**	**Topics**
	SorBET, nQuire for students	Recycling
	SorBET, nQuire for students	Types of forces

Researchers and two teachers from the UK co-designed two activity plans for Year 7 and 8 students. Figure 11 below highlights one of them.



\]DESIGN THINKING ACTIVITY PLAN TEMPLATE YEAR 2

1. BASIC INFORMATION

PROJECT TITLE:

Title of the Design Thinking (DT) Project: improving our recycling at school due to the new government regulations.

AUTHOR(S):

231101, Sagun Shrestha, Christothea Herodotou

ISSUE

Schools are not recycling packaging correctly; the Welsh government are looking to fine schools who are not recycling in line with government guidelines. Our school is now raising awareness and creating new labelled bins to ensure we are recycling correctly.

FINAL STUDENT PRODUCTION:

What is the expected final artifact that will be produced by the students using emerging technologies throughout the DT project?

1 Simulation game to share with other students to educate them on the correct ways to recycle.

2 Feedback obtained from students who have played their games via the nQuire for students platform.

TECHNOLOGIES TO BE USED:

Select the ExtenDT2 technologies that will be used by students during the DT Project

☒ MaLT2 ☐ ChoiCo ☑ SorBET ☐ VRobotics ☑ NQuire

Figure 11: A snapshot of the sample activity plan co-developed by a teacher and a researcher in the UK

The topic chosen for Year 7 students was types of forces and for Year 8 students recycling. Both activities were planned for six hours spread across six sessions over six weeks and engaged students in developing games on SorBET to tackle the issue of recycling and understanding types of forces. nQuire for students was used to collect feedback related to their games. Further details on the activity plan for recycling is provided below.

The activity plan related to recycling (Figure 11) lists the following learning objectives: deciding what recyclable materials go into each bin, creating different SorBET games, interpreting questionnaire answers to finalise the game, relating the feedback from students' peers to iterations to prototypes and discussing different solutions to the issue at hand.

During stage 1 of DT, students discuss the issue with the teacher and ask questions related to recycling to raise awareness on recycling. At stage 2, each group of students plays a SorBET game, becomes familiar with the functionalities of technology, and defines parameters such as what pictures and images they will use while developing a game. In stage 3, students create different games on SorBET related to recycling, they test them by playing them and decide which game to share for feedback. At phase 4, students design a set of questions on nQuire for students to collect feedback on the game they designed, and share the link to the questionnaire to get feedback from other students. In phase 5, students go through the feedback given by their classmates and tweak their game.

5.1.4 NTNU (Norway)

Number of activity plans:	5: 3 (implemented) plus 2 designed but not implemented in a classroom	
Activities using project technologies	**Technologies**	**Topics**
	GearsBot and nQuire for students	Inclusivity
	GearsBot and nQuire for students	Recycling
	SorBET and nQuire for students	Artificial Intelligence
	ChoiCo and nQuire for students	Environment and energy
	VRobotics and nQuire for students	Traffic laws

In Norway, teachers and researchers co-designed 3 activity plans to be implemented in 9 classes in both private and public schools. Each intervention lasted for 6 hours. The activity plans were co-designed to deal with issues, such as inclusivity, recycling and artificial intelligence, and the tools used in the intervention were GearsBot, SorBET and nQuire for students. Below, we provide details on one of the activity plans. In addition two activity plans were co-designed, as part of a workshop related to project objectives, co-design and Professional Development activities, but not implemented (See D5.3 for further details). Their topics relate to environment and energy, and traffic laws. They make use of ChoiCo, VRobotics and nQuire for students and were designed to last for 12 hours.

The activity plan related to inclusivity (Figure 12) lists the following learning objectives: identifying accessibility and inclusivity challenges in different personas and scenarios, translating personas' accessibility challenges into the planimetry design to ensure an accessible school environment, illustrating the protagonist's (VRobot) interaction in the GearsBot by coding the behaviour via block-based programming or python textual interface, demonstrating the validity of the created planimetry regarding accessibility by coding the VRobot's behaviour using block-based programming or the Python textual interface and creating different prototypes of classroom/school layouts to improve their accessibility.

4. STUDENT ASSESSMENT AND FEEDBACK

What methods and tools will you use to facilitate the assessment of the learning outcomes stated in section 3.1? (e.g., post-activity tests, reflective videos, student worksheets, etc.).

TOOLS

Describe the assessment tools that will be used:

Rubrics were used to evaluate students' worksheets; rubrics were used to evaluate students' responses from nQuire feedback templates; rubrics were used to analyse SorBET artefact (namely, the "Database" creation); observer notes were focused on single groups.

APPROACH

Describe the formative and summative assessment activities. How these assess the achievement of the learning objectives as described in section 2.1.

Learning Outcome	Assessment Activity
***Identify** possible challenges in different personas and scenarios from their everyday life [...].*	*Worksheet evaluation, specifically the first actions required on worksheet number 1.*
***Translate** personas' everyday challenges into the storyboard to contextualise their difficulties and resulting needs and to elaborate storytelling.*	*Worksheet evaluation, specifically the first actions required for the last prompts on worksheet number 1 and the storytelling activity supported by worksheet number 2.*
***Illustrate** the composition of the "Database" (the items chosen to*	*The rubric should be applied to the SorBET artefact, paying attention to the classification table and the arrangement of the coding blocks.*

Figure 12: A snapshot of the assessment plan within the activity plan developed by a teacher and researchers in Norway

In phase 1, the teacher introduces the core concepts of "Inclusivity" and "Accessibility" with an interactive presentation. The Design Thinking strategy is also presented in all its steps. The participants are prompted to share their experiences to further elaborate on these concepts. A "deck of cards"with different user personas (the cards include a brief description of the needs, challenges, and opportunities based on real inclusivity/accessibility issues) is distributed to every group. After a brainstorming session internal to the group, the teammates are asked to come up with their own persona, namely the "protagonist" of their design thinking intervention. To support this passage, each group is provided with a first worksheet with prompts to guide the creation of their protagonist. In phase 2, participants are provided with a planimetry template of school environments to be modified or created to ensure accessibility according to the protagonist's needs. Moreover, participants receive information about the subsequent transposition of their filled template in the GearsBot (VRobotic) environment as an interactive setting, where the robot will metaphorically represent their protagonist. In phase 3, the teacher uploads the latest versions of the planimetry for each group onto the ExtenDT2 platform. This allows the groups to access a GearsBot world customised with their own classroom planimetry to contextualise the task better. The VRobot is now the metaphor of the chosen protagonist. The facilitator proceeds by illustrating a brief tutorial on how to teach the robot to go straight on, turn right and turn left. Students are then asked to recreate the path of their protagonist in the GearsBot world by simulating interactions with the classroom environment, including furniture, lighting systems, and directional signs they designed. The movements of the VRobot can be programmed via a block-based interface. If the pupils want, they can do the same task but increase the challenge using Python. At phase 4, once the VRobot's path has been coded to explore the accessibility of the classroom environment, the students exchange their creations within their groups. After playing the GearsBot game coded by another group and discussing it internally, each group access nQuire for students for another round of feedback focusing on the planimetry's accessibility and the quality of VRobot's coded behaviour. Finally, the groups are prompted to discuss the feedback received with their teammates and then proceed to refine their prototypes by improving both the planimetry (a third worksheet is provided by the teacher) and the code. At phase 5, all the groups are asked to summarise their DT journey with a presentation. In the presentation, each group should state their protagonist, their planimetry, their experience in implementing it with GearsBot, and how it improves (or not!) according to the feedback received from the other groups.

5.1.5 UGent (Belgium)

Number of activity plans:	2	
Activities using project technologies	**Technologies**	**Topics**
	ChoiCo	Sustainable living environment
	ChoiCo	Sustainable fashion, sustainable food and sustainable school management

Researchers and teachers in Belgium co-designed two design thinking activity plans around the issues relating to sustainable development and other wicked problems such as sustainable fashion, food and school management. Teachers planned to engage students for 8 hours on the issue of sustainable learning environment and planned to engage studentss for 16 hours with sustainable fashion, food and school management. Below we detail one of the activity plans.

The activity plan related to sustainable fashion, sustainable food and sustainable school management (Figure 13) lists the following learning objectives: recognizing the relationship between society and STEM- disciplines, stating different solutions for a well-defined wicked problem and evaluate and argue the consequences, recognizing that a "good" solution to a problem depends on the perspective and specific needs of the user, designing, developing and creating a ChoiCo prototype and analyzing the present living environment in a given city with respect to the relationship between living environment and STEM disciplines.

ISSUE:

Within the "open hours" in the curriculum for GO!-3th grade, the school organizes seminars of 2 class hours/week. The aim of these seminars is to conduct research on the two main subjects and work on their research competencies (abbreviated: OCs).

The Wicked problem project was run as a fulfilment of the research assignment for the subject Economics, at 6 Economics-Modern Languages (6EMT). During Q1 of 2024, a total of 8 sessions of 2 class hours were organized in which students in groups of 4-5 people delved into a 'wicked problem.' The different phases of design thinking were gone through for 3 global challenges: sustainable fashion, sustainable food and sustainable school management.

FINAL STUDENT PRODUCTION (= deliveries)

1. Each team provided a ChoiCo simulation with choices about their concrete problem statement with a set of criteria (see below).

2. Each team also delivered an infographic outlining the broader "wicked problem," this infographic can be used complementarily with the game.

3. At the request of the students and colleagues, a final presentation in front of a jury about their project is also provided, as this is common practice at OCs.

TECHNOLOGIES TO BE USED:

ChoiCo software for the development of the game.

Canva (free version) for the development of infografics

2. FOCUS, SET UP & REQUIREMENTS OF THE ACTIVITY

2.1 LEARNING OBJECTIVES :

Learning goals economics course, 3th grade. Flemish community education 'Gemeenschapsonderwijs, Vlaanderen'

Students reflect on economic models and sustainable economic development. - sustainable development: sustainable society, sustainable development goals - circular economy - alternative economic models

Figure 13: A snapshot of the activity plan codesigned by a teachers and researchers in Belgium

In phase 1, the students are coached towards narrowing down the challenge they are asked to address using DT. They narrow this down as follows: From starting a fashion brand >> designing a sustainable school uniform. Starting a new, fully sustainable cafeteria >> management of the existing school canteen. Narrowing down the whole institution approach (courses and organisation and infrastructure of higher education) >> reducing the climate impact and enhancing the wellbeing of students. In phase 2, the teacher shows an example of a ChoiCo game, to make clear to the students what is expected from them. Then they suggest a range of possible solutions to improve the situation better for users. The students finalize their interviews with online feedback provided by the teacher before the session. To cover the learning goals of 'economy', students investigate how prices are built up in the sector. In phase 3, the students analyze the possible impact of proposed solutions on economy, society etc and put their findings in a table in a google doc or paper sheets. After receiving feedback from the teacher, they start quantifying measures and impacts as part of a multi-criteria analysis, based upon data received from desktop research or an interview, after which they assign values to the impacts. This way students create a paper prototype of their ChoiCo simulation. They then create a digital prototype and program their simulation. In phase 4, during the first two hour session, an Exten.(D.T.)^2 project member and a post-doc researcher support students in their first development steps. The students can also work on the development of their ChoiCo game during a two hour scheduled session on informatics, with support from the teacher of informatics. Two members of each group create an infographic in Canva, as a visual summary of the knowledge gained. In phase 5, classmates and teachers test and evaluate both the game and the infographic.

5.1.6 TCD (Ireland)

Number of activity plans:	1	
Activities using project technologies	**Technologies**	**Topics**
	MalT2, ChoiCo, SorBET and nQuire for students	Fast fashion

In Ireland, a teacher and a researcher co-designed one activity plan related to fast fashion. They decided to engage pupils in using technologies such as MaLT2, ChoiCo, SorBET and nQuire for students. The plan was spread across 7 weeks, each session lasting for an hour. Students were divided into 6 groups, having 3 students in each group.

The activity plan related to fast fashion (Figure 14) lists the following learning objectives: creating change in end-users' behaviours and/or attitudes towards fast fashion by accurately communicating relevant and current information on fast fashion, designing a game or product using one emerging technology that attempts to solve a fast fashion-related issue, experimenting and familiarising themselves with MaLT2, ChoiCo, and SorBET using a variety of already designed games, "half-baked" games and/or basic programming codes, defining a fast fashion-related issue in their local community by analysing and understanding results from the nQuire for students survey and generating solutions with MaLT2, ChoiCo or SorBET to solve the fast fashion-related issue they identified.

In phase 1, the teacher will provide students with the KWL chart on fast fashion. The KWL chart has three sections namely, what I know (K), what I want to know (W) and] what I learnt (L). Students will examine different people involved and potentially impacted during the different stages of fast fashion. Groups will explore online resources on fast fashion provided by the teacher to strengthen their knowledge of the issue. Also, student groups will brainstorm at least seven questions that could be used to find out what someone knows about fast fashion.

ISSUE:

Fast fashion

FINAL STUDENT PRODUCTION:

A game or product, using MaLT2, ChoiCo, or SorBET, that will attempt to solve a fast fashion-related issue. The specific issue addressed in the final product will be identified by the students after they review responses from the nQuire survey.

TECHNOLOGIES TO BE USED:

Select the ExtenDT2 technologies that will be used by students during the DT Project

■ MaLT2 ■ ChoiCo ■ SorBET ☐ VRobotics ■ NQuire

2. FOCUS, SET UP & REQUIREMENTS OF THE ACTIVITY

2.1 LEARNING OUTCOMES

You can find the Learning objectives Verbs here

Domain Related	
Civic, Social & Political Education	Students should be able to create change in end-users' behaviours &/or attitudes towards fast fashion by accurately communicating relevant and current information on fast fashion
Computer Science	Students should be able to design a game or product using one emerging technology that attempts to solve a fast fashion-related issue
Design Thinking & innovation with Emerging Technologies Related	
Empathy	Students should be able to empathise with their end-users (local community) by creating 1 -2 questions that involve users' knowledge and/or emotions towards fast fashion
Experimentation	Students should be able to experiment and familiarise themselves with MaLT2, ChoiCo, and SorBET using a variety of already designed games, "half-baked" games and/or basic programming codes
Define	Students should be able to define a fast fashion-related issue in their local community by analysing and understanding results from the nQuire survey

Figure 14: A snapshot of the activity plan co-designed by a teacher and a researcher in Ireland

In phase 2, students will discuss and analyse nQuire for students survey results, and they will define one issue to tackle based on survey results. They will create a "How Might We" Question to outline the issue the group wants to solve. They will ideate solutions with all three technologies to answer the "How Might We" question. In phase 3, the teacher will assign group roles and establish times for rotation of roles between group members such as, a computer controller: manages & uses software to create game/product, a computer assistant: keeps a close eye on the computer controller to make sure information is correct & to see if anything should be added or changed and a recorder: observes group, contributes to iteration of a game / product & records important changes made with technology. Students develop prototypes on technology and record what they did, different variations they tried, challenges faced, new ideas, etc.

In phase 4, students review their prototypes and provide opportunities to record any iterations made. There will be a peer review session in which group A gives a demonstration and Group B provides feedback and vice versa. A final workshop will be organized in which students reflect on feedback and discuss final steps so that their solution is completed by the end of a class. Finally, in stage 5, there will be group presentations in which each group will have 3 to 5 minutes to give a demonstration of their game, provide relevant information and answer questions.

6 Conclusions

In Year 2, digital technologies have been extended with new functionalities. For example, ChoiCo has been extended with Google map and live traffic data, SorBET with gesture recognition, and MaLT2 with 3D printing functionalities. Nineteen (N=19) new activity plans have been co-designed and seventeen (N=17) of them have been implemented across Europe covering a wide range of issues such as cybersecurity, entrepreneurship, recycling, sustainable development issues and fast fashion. Each activity plan has different timeframes for classroom implementation, ranging between 6 to 16 hours and follows the project's model of digital design thinking.