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Deliverable 5.1
Report on the Activity Plans for School Interventions (v. 1)

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Abbreviations

Exten(DT)2	Extended squared
NKUA	National and Kapodistrian University of Athens
WP	Work Package
DT	Design Thinking
ET	Emerging Technologies
ChoiCo	Choices with Consequences
MaLT2	Machine Lab Turtleworlds 2
SorBET	Sorting Based on Educational Technology

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1. SUMMARY

The deliverable 5.1. "Report on the activity plans for school interventions" reports on the work done in Task 5.1 "Design Exten(DT)2 Interventions for schools". Section 2 clarifies the purpose and objectives of the deliverable and explains the connection of Work Package 5 (WP5): "School Interventions" with other work packages of the Exten(DT)2 project. To support the design and implementation of digitally-based Design Thinking (DT) interventions we developed a strategic document called "Design Thinking Activity Plan Template". Section 3 describes the theoretical rationale that underpins the design of the "Design Thinking Activity Plan Template". It then describes the process that was followed in M1-M5 for developing its first version and presents the first version of the template document in subsection 3.3. In section 4 we provide and discuss four examples of DT Activity Plans. These were developed by NKUA as guidelines and inspiration for partners and teachers who will co-design Activity Plans for school interventions in the next months. In section 5, we discuss the next steps for WP5 during M6-M12, when the co-design of new Activity Plans by stakeholders and the implementation of the first year's school interventions will take place.

2. INTRODUCTION

2.1 Purpose & Objectives

The deliverable 5.1. is the first of the four deliverables of WP5 "School Interventions", which concerns the iterative design and implementation of digital-based DT interventions with students that will provide evidence on the effectiveness of the project's approach and technologies.

The deliverable reports on the work done in Task 5.1 "Design Exten(DT)2 Interventions for schools", in which "*scientists will collaborate with teachers, industry partners, and policy-makers to co-design Design Thinking cases that will concern real-world issues and wicked problems. They will further design the interventions for implementing the cases in schools utilizing the Exten(DT)2 educational resources (WP3) and technologies (WP4)*."
To support and guide this process we have developed a strategic document, "Design Thinking Activity Plan Template", that will be used throughout the project for the co-design, reflection and reporting of DT activities with the Exten(DT)2 Emerging Technologies (ET).

The "Design Thinking Activity Plan Template" is a strategic document that identifies the critical elements, structure and flow of a DT educational activity with ET. It is structured in a way that addresses the teacher's personal pedagogy, beliefs, knowledge, reflections, and practice. It has been designed to:

- be pedagogically grounded on the Design Thinking Methodology,
- address the particular characteristics of Exten(DT)2 Technologies as teaching and learning tools for DT,
- be adaptable to different learning settings and contexts (virtual/in person, in and out of school, across the curriculum and educational levels),
- generate different examples of DT activities for the different types of Exten(DT)2 technologies, and
- make explicit the implicit aspects of the learning environment in the context of a DT project.

This version of D5.1. reports on the "First version of the Activity Plan Template" document that was developed during the first five months of the project and will be used by educators to co-design Activity Plans for Cycle 1 school interventions. It also reports and discusses four Activity Plans designed by NKUA which will be used as first examples to support and inspire Exten(DT)2 partners and educators in co-designing their activities. This is the first version of D5.1. It will be continuously updated in the first 2 years of the project based on refinements by involved stakeholders and the actual development of new Activity Plans. The final version will be submitted in M24, and will include the final version of the DT Activity Plan Template and the Activity Plans co-designed with teachers as part of Task 5.1 and WP3.

2.2 Connection to Other Project Activities

Figure 1 shows the connections between WP5 and other WPs of the project. The "Design Thinking Activity Plan Template" has taken into account the literature review of **WP2** which identifies the current challenges, opportunities and best practices of implementing DT projects in educational settings (see **D2.1**). WP5 evolves in relation to developments in **WP3** (Co-design of Educational Resources and Material) which concerns the co-design and co-development of, a) educational activities about the project technologies, b) supporting material as to how to use these activities with learners, and c) teacher training material to support the design and implementation of Digital Design Thinking activities. Thus, the outputs of these activities have informed the initial structure of the Activity Plan Template and the content of the Activity Plans co-designed by teachers. It is also strongly connected to **WP4** (Shaping Technologies) which has the goal of extending existing tools *"with emerging technologies for the digital enhancement and transformation of Design Thinking learning*". Since the use of project technologies is a central part of the Activity Plan Template, the outcomes of WP4 directly affect the Activity Plan structure and content. Finally, WP5 feeds into **WP7** (Evaluation) which "*provides evidence for the development and refinement of tools and activities as used and implemented by teachers in the project*". The structure of the Activity Plan Template reflects the needs of the project evaluation and the research question WP7 strives to answer. Moreover, the refinement of the Activity Plan Template and the Activity Plans for the next cycles will be based on data analysis, which will be reported in **D7.1, D7.2 and D7.3**.

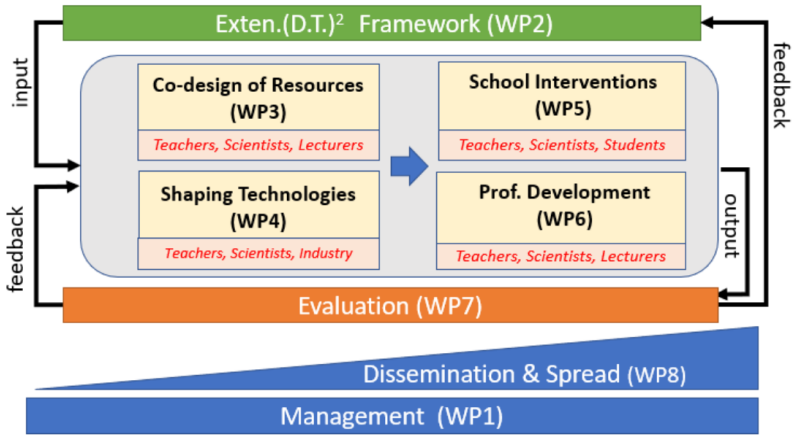

Figure 1: Connection of WP5 to other WPs

3. THE "DESIGN THINKING ACTIVITY TEMPLATE"

As all activities for the school interventions will be designed with the DT Activity Plan Template, it is important to describe the rationale and the process of its development. This section explains the main principles that guided the design of the template, reports on the process followed by the NKUA team, and presents its first version.

3.1 Theoretical Rationale of the Design Thinking Activity Template

The template provides a generic but well-structured design instrument that identifies critical elements of DT teaching and learning based on theory and practice and is expected to contribute to the description of effective DT activities with ET. Our aim was to find a balance between, a) a level of abstraction that it will make the template adaptable to different settings, and b) a level of detail that will demonstrate the influence of a specific pedagogical approach. It will address the particularities of DT as a pedagogical activity and it will augment the affordances of the specific Emerging Technologies used in each Activity Plan. The template was designed with the purpose to function as a mediating artifact between the researchers and the stakeholders interested in designing Activity Plans for DT with ET.

The main pedagogical theory underlying the design of the DT Activity Plan Template is constructionism (Ackerman, 2001, Kynigos, 2015, Papert, 1980), where learners put concepts into use and generate powerful ideas through constructing and tinkering with digital artifacts with personal meaning. Through that view, in DT projects, students utilize technology as an expressive medium to experiment with, develop and exchange a number of personally meaningful artifacts. These artifacts continuously evolve and change during the DT project, and through them children express their personal ideas on the DT topic and related concepts. Another aspect underlying the design rationale of the template is the emphasis on the social dimension of the co-construction process with technologies aiming to cultivate a specific learning attitude growing out of sharing, discussing, and negotiating during the design thinking process. Such processes are strongly connected to learning but also skills development and can be leveraged by the use of easily accessible and authorable digital tools (Kafai & Bruke, 2017).

Previous research work, in the field of educational technology, has shown that using the Activity Plan Template approach can support teachers to develop and implement learning activities using new technologies they are unfamiliar with, and at the same time, facilitate conversations between researchers and teachers for the activity design, enhancing co-creation processes (Yiannoutsou et. al. 2017; Kynigos, Grizioti & Gkreka, 2018). Moreover, it can be a valuable tool for the evaluation of research interventions as it provides a thorough and well-structured document not only for the activity setting, but also for teacher rationale behind the integration of technology with pedagogy for each activity. Based on this in Exten(DT)2 we have developed an Activity Plan Template for a novel situation; that of Design Thinking enhanced with Digital Technologies.

The first version of the “Design Thinking Activity Plan Template” was further informed by the challenges, best practices and requirements of integrating Design Thinking in educational settings, with or without technologies, as identified in the WP2 literature review (see D2.1).

Some challenges recognized in the literature that guided the design of the template are the following:

1. DT and students self-efficacy: lack of critical feedback on the skills participants demonstrate (e.g. creativity, innovation, critical thinking) (Stith et al., 2020)
2. DT and the gap between process and subject domain as well as its connection to the curriculum (Carroll et. al., 2010)
3. DT exposes the challenge of learning through productive failure (Stith et al., 2020)
4. DT projects may cause confusion and frustration to students who are engaging in such projects for the first time, due to the high ambiguity and "messiness" of the process (Panke, 2019; Glen et al., 2015)
5. DT projects and problems in student group dynamics, e.g. student roles, conflicts management, active engagement, ownership of the productions (Goldman et al. 2014)
6. DT and educators problems with monitoring all groups and assessing the learning process and outcomes (Al-Zebdyah, 2022)
7. DT and problems with connection to school structure, regulations and norms (Al-Zebdyah, 2022)

The "DT Activity Plan Template" aims to tackle these challenges by exploiting the opportunities offered by ET for transforming DT into a valuable, resilient and pedagogically robust approach, applicable to different educational contexts. Thus, it was designed to provide stakeholders with a tool for designing Activity Plans that integrate key learning activities into a DT project such as the following:

- focus on skill development and self-reflection through the online sharing of digital productions and collection of feedback (Challenge 1)
- focus on identifying and bringing to the foreground the concepts from different domains that students are expected to experiment with and put into use during the DT activity (Challenge 2)
- transition from subject-specific to transdisciplinary activities on real challenges and wicked problems involving the use of digital media and the cultivation of digital skills such as Computational Thinking (Wing, 2008) (Challenges 1 & 3)
- identify key 21st-century skills that may emerge from the activity including collaboration, argumentation, taking individual responsibility in groups, creativity and innovation, coding/programming, interactions (Voogt & Robli, 2010). (Challenges 1 & 3)
- integrate digital media as tools for modelling, co-construction and rapid prototyping throughout the DT process and not only in certain stages. Such media allow for continuous experimentation, expression and testing of ideas, without any physical restrictions, promoting learning through productive failure and creativity (Diamantidis & Kynigos, 2022; Dickson, B. et al. 2021). (Challenge 3)
- use of artifacts built with online authoring systems that allow for robust longitudinal learning gains. Online authoring systems support non-technical users like students develop and share their own digital products, providing a tangible and accessible

means to structure the DT process and deal with its ambiguity issues (Challenge 4)

- focus on students digital constructions with the use of emerging technologies as the output of the DT process. Digital constructions can seamlessly embed concepts and skills from different domains (Challenge 2) and at the same time enable teacher monitoring and evaluating group progress through analytics (Challenge 5)
- focus on group formation and dynamics before the activity (Challenges 6 & 7)
- focus on the teacher roles and strategies for supporting learning and skill development through a DT project with ET (Challenges 7 & 8)

Acknowledging design as an important aspect of the teaching profession, our aim is to equip educators with a structured means to describe and share their practices. In this context the Activity Plan operates as an expressive medium for teachers and educators, an instrument for sharing, communicating, negotiating, and expanding their ideas, mediating the co-design process by helping members of different disciplines to gain an understanding of each other's perspectives and knowledge on, a) the use and educational potentials of the Exten(DT)2 ET in DT, and b) the particularities of DT Methodology as an innovative pedagogical approach.

During the Exten(DT)2 project the "DT Activity Plan Template" is expected to function as:

- A tool for organizing and implementing a DT activity in the classroom with the Exten(DT)2 Emerging Technologies.
- A tool for designing and reflecting on activities as part of teachers professional development.
- A tool for evaluation of the learning and teaching practices designed for the interventions, as it provides the means to keep track of what has happened in the classroom.
- A tool to present the Exten(DT)2 school implementations to a wider audience in a structured way, as it provides metadata for different kinds of DT activities with students (e.g. age, technology used, final DT product, topic of DT project, related subjects).

3.2 Design Process of the Template

Below we describe the methodology we followed to develop the first version of the "Design Thinking Activity Plan Template":

- A first draft of the Activity Plan Template was created by NKUA research team at M3, based on review of existing DT frameworks and previous work on activity plans that involved innovative use of technologies for teaching and learning (Yiannoutsou et. al. 2017).
- The second step was to use the Template for creating some examples of suggested Activity Plans that employed the project technologies in DT school projects. In M3 four educators and researchers from NKUA collaborated and developed four DT Activity

Plans examples. The examples are presented in detail in section 4. They also provided written feedback on the Activity Plan Template which was taken into account for creating the first draft.

- The first draft of the DT Activity Plan Template and the four Activity Plan examples were shared internally with all partners asking for their written comments and feedback.
- In M4 the consortium had an online internal workshop for discussing the Activity Plan Template structure and the examples through hands-on activities. During this meeting NKUA noted from feedback provided, further ideas and possible issues, on the template.
- Based on the outcomes of this workshop, and the results of literature review for WP2, in M4 NKUA refined the structure of the Activity Plan Template and finalized the first version and the four examples. Below are some examples of received feedback that have influenced the document redesign:
    a. *The importance of making ExtenDT2 approach more explicit in the template, supporting teachers to think of meaningful ways of using the project Emerging Technologies to support the DT project and the learning goals throughout the activity.* To address this, the template prompts the designers to think the role of Exten(DT)2 technologies in all sections of the Activity Plan. This includes specifying from the beginning the technologies to be used, defining expected "Emerging Technologies Related" learning outcomes and ways to assess them, and describe the expected usage of Exten(DT)2 technologies in each DT phase.
    b. *The activity designer (e.g. teacher) must think about and define the issue that the DT project aims to address as well as the role of technology to that, from the beginning*. To address this, the template asks the designers to define the DT project issue and the expected student production as part of the basic activity information, but also to explain the rationale of choosing that issue in the "summary" section. There, they provide a short description of the DT project clarifying, a) the rationale behind the selected DT project issue, b) the expected use of (emerging) technologies for creating a solution to this issue, and c) the artifact(s) students are expected to construct using this technology.
    c. *The expected learning outcomes must be in alignment with the project topic and the subject domains it involves*. To support teachers think about explicit learning objectives that reflect the multidisciplinarity and skill-oriented nature of Exten(DT)2 activities, the template provides a "Learning Outcomes" table with four distinct but interrelated types of learning outcomes: Domain Related (for the domains mentioned earlier), (Emerging) Technologies Related, Design Thinking & innovation related, 21st century Skills Related.
    d. *Define some minimum requirements (e.g. time, group size) so that the activity is in alignment with the DT methodology, without limiting teachers freedom and taking into account classroom and school restrictions*. To sufficiently

support the four DT stages, the template defines 6 hours as a minimum activity duration. Moreover, to enable efficient collaboration and co-creation with technologies it requires that students work in groups of minimum 2 and maximum 5 and asks the designer to think about and describe grouping criteria and group dynamics (e.g. roles in the group).

e. *Make more explicit what it is meant by student assessment and how it connects to learning goals.* The Activity Plan has a separate section on student assessment where it asks the designer to think of and describe the tools, methods and procedures that can be used to facilitate the assessment of the learning outcomes previously stated. It also provides examples of both group and individual assessment methods and tools, to support teachers reflect on what type of evaluation better fits the designed activity.

The finalized first version of the plan will be used in co-design activities with teachers (WP3) and professional development courses (WP6). During the implementation phase, we plan to collect data that will allow us to evaluate, refine and re-design the activity plan template so that this would result in a useful and moreover, a pedagogically grounded instrument for designing DT activities with ET. The Activity Plan template will be further developed during the whole lifecycle of the Exten(DT)2 project. Regarding the implementation phase, these are the steps we will follow within the first year of the project:

- Teachers use the Activity Plan template in order to co-design with researchers and/or other teachers learning activities of DT projects with the Exten(DT)2 technologies as part of WP3. In Year 1 they can select to use one or more of the existing project technologies for implementing a DT project of their choice.
- Teachers implement their Activity Plan with students in real educational settings.
- Teachers reflect on the implementation of their Activity Plan and give us feedback.
- Researchers together with teachers refine the Activity Plan in accordance with the experience gained during the previous phases and the results of data analysis and evaluation in WP7.
- The Activity Plan will also be used as a design instrument by pre or in-service teachers in the pilot professional development courses (WP6). Participating teachers will use it to describe a potential DT activity with one or more Exten(DT)2 Technologies as part of their course assignments.

3.3 Structure of the Template

In this sub-section we discuss the rationale, as well as the main structure of the first version of the Activity Plan template. The structure of the Activity Plan template includes the following aspects:

- the description of the DT project with reference to the different domains involved, the issue it concerns, and the targeted audiences,

- different types of learning objectives, duration of activities and necessary material,
- contextual information regarding space and characteristics of students,
- expected use of Exten(DT)2 Technologies as part of the whole DT process, rather than only the develop stage which is usually done in traditional DT approaches (Pank,2019),
- social orchestration of the activity (group or individual work, formation of groups, etc.),
- a description of the teaching and learning procedures structured in the different phases of DT methodology,
- expected student constructions, and
- means of student evaluation and assessment.

Aligning with the above features, the template is divided into the following five sections:

Section 1 "BASIC INFORMATION": includes an overview of how the DT issue, ET and different subject domains are integrated into the activity. The aim is to highlight the use of technology for solving the project's DT issue as well as the different domains that may co-exist in that process.

Section 2 "SUMMARY": aims to highlight the activity designer's pedagogical agenda and rationale behind the DT activity and the use of ET in a descriptive way.

Section 3 "FOCUS, SET UP & REQUIREMENTS OF THE ACTIVITY": concerns, a) the learning *outcomes* in relation to four key elements of a DT activity with digital technologies (Domain related, Technology related, DT & innovation related and 21-century skills related outcomes), b) the characteristics of the implementation contexts and participants, c) the *social orchestration* with a focus on grouping criteria and dynamics to be defined before the activity, and d) the digital or physical material necessary for supporting student engagement and learning throughout the activity.

Section 4 "IMPLEMENTATION - DESIGN THINKING ACTIVITY FLOW" involves the detailed description of the activity flow through the distinct stages of the DT methodology and the expected use of technology in each of them. It is structured in four stages according to the 'Double Diamond' DT model of the Design Council[1]. We chose this model as these four stages provide a more concise but also clear and comprehensive description of the process of design as a whole, in comparison to other DT models (Örnekoğlu-Selçuk et al. 2022). It puts emphasis on the diversion and conversion phases of DT, which are important for students to understand, and also to the iteration between them. The four stages are:

[1] Design Council UK. (2021). *What is the framework for innovation? Design Council's evolved Double Diamond*. https://www.designcouncil.org.uk/news-opinion/what-framework-innovationdesign-councils-evolved-double-diamond. Accessed 03 February 2023.

1. Discover: where students use technologies to explore (diverge) and understand the problem of their Design Thinking project for which they will develop a solution.
2. Define: where students use the technologies to ideate, set criteria and make decisions on specific features (converge) of the final artifact based on the information explored in for example phase 1.
3. Develop: where students use digital authoring systems to design, exchange, test, and redesign rapid prototypes (diverge) for their artifact until a final version is ready.
4. Deliver: where students focus on (converge) the delivery and communication of their final artifact to the target audience and the public, using technologies.

Each of the four phases presents five distinct components which aim to highlight key aspects of transforming DT into a pedagogical activity with ET and enable educators to think and express their own pedagogy on them. These refer to, a) the duration of each phase, an aspect we know many teachers struggle with, b) a short description of what students will do in that time and what the goals of that phase is in relation to the DT project as a whole, c) how the Exten(DT)2 technologies are planned to be used by students and/or teachers to achieve the goals of that phase, d) what digital productions are expected by the students at the end of each phase, after having used the selected technologies, and e) what the expected interactions, dynamics and roles in the student groups are and how the teacher and/or technologies will support them.

Section 5 "STUDENT ASSESMENT": concerns the procedures, methods and tools that can be used for the assessment of the expected learning outcomes described in section 3. This part is meant to foster (the) activity designer(s) to reflect on whether the learning outcomes are clear, relevant to and achievable through the described activities and how they can be assessed.

The first version of the Activity Plan template is shown below.

3.4. First Version of the Design Thinking Activity Plan Template

DESIGN THINKING ACTIVITY PLAN TEMPLATE

1. BASIC INFORMATION

PROJECT TITLE:

Title of the Design Thinking Project as it is mediated to students

AUTHOR(S):

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

ISSUE:

What is the issue that the Design Thinking project deals with?

E.g. The biodegradable material in jewelry 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 Exten(DT)2 technologies that will be used by the students during the DT Project

☐MaLT2 ☐ChoiCo ☐SorBET ☐VRobotics ☐NQuire

DOMAINS:

Specify the domains (subjects) involved in the DT project and give a rating of the level of emphasis on concepts from each of them from 0 to 10.

E.g. mathematics: 8/10, chemistry 2/10, environmental education 5/10, Computer Science 6/10 other (specify).

2. SUMMARY

Provide a short description of the DT project clarifying:

a) the rationale behind the selected DT project issue

b) the expected use of (emerging) technologies for creating a solution to this issue

c) the artifact(s) students are expected to construct using this technology

3. FOCUS, SET UP & REQUIREMENTS OF THE ACTIVITY

3.1 LEARNING OUTCOMES

Domain related (for the domains mentioned in section 1)	*e.g. Discover the mathematical properties of the 3D shapes used for designing the digital jewel model*
	e.g. Decide on the material for printing the 3D model (Chemistry)
(Emerging) Technologies Related	*e.g. Programming GIS games, Robotic circuits, Logo programming, Interpret data*
Design Thinking & innovation Related	*e.g. develop empathy, develop presentation and communication skills, ability to create rapid prototypes*
21st century Skills Related	*e.g. collaboration, creativity, critical thinking*

3.2 PARTICIPANTS & CONTEXT

STUDENTS

Age	*10-11 years old*
Prior knowledge	*basic knowledge of programming concepts with Scratch*
Nationality, gender cultural background	*1 pupil is from Albania and 21 from Greece, 15 boys & 7 girls*
Language	*Greek*
Special needs and abilities	-

TIME

ACTIVITY DURATION: *e.g. 8 hours divided into 4 times* ***(NB: min 6 hours - 2 times in total)***

IMPLEMETATION DURATION: *e.g. 4 weeks*

SCHEDULE*: e.g. 2 hours/week*

SPACE

Specify where the activity will take place

ACTIVITY TYPE: ☐ In-person ☐ At distance ☐ Mixed

PHYSICAL SPACE: *e.g. computer laboratory, classroom*

VIRTUAL SPACE: *e.g. Moodle platform, Miro Platform MS-TEAMS platform, E-class*

3.3 SOCIAL ORCHESTRATION

POPULATION

NO OF STUDENTS: NO OF GROUPS: NO OF TUTORS: NO OF ASSISTANTS:

STUDENT GROUPING & INTERACTIONS

Grouping Criteria	*e.g. mixed school performance, student preferences*
Setting	*e.g. 3 students per group using 1 computer per group and sharing 3 tablets between groups* ***(min 2, max 5 students/group)***
Roles in the group	*e.g. pre-defined roles; emergent roles; role exchange in the group*
Tutor(s) role(s)	*e.g. intervene; monitor; facilitate; guide; observe*

3.4 SUPPORTING ARTIFACTS & MATERIALS

Digital artifact(s)	*e.g. basic 2D & 3D models created by the teacher in MaLT2 (a pyramid, a cube, a circle)*
Physical artifacts & material	*e.g. a 3D printed model, workbook*
Supporting material	*e.g. MaLT2 video tutorial, teacher's instructions (printed)*

4. IMPLEMENTATION - DESIGN THINKING ACTIVITY FLOW

This section describes how the teaching and learning process is expected to evolve through the 4 phases of the Design Thinking Methodology: Discover, Define, Develop and Deliver[2]. The described activities should support the objectives stated and make use of the technologies, supporting material, and teaching and learning processes mentioned earlier in the activity plan. The engagement with the 4 stages should be iterative and not linear.

PHASE 1: DISCOVER

In the "discover" phase students explore (diverge) and understand the problem of their Design Thinking project for which they will develop a final artifact. This involves, for example, empathizing with people who belong to the target audience and understanding the needs of the potential users. In this phase, students can use the Exten(DT)2 technologies to understand the topic (e.g. to play a game on the topic predesigned by the teacher) and create online surveys in nQuire asking questions to the target audience to discover their needs.

DURATION: *e.g., 2 hours*

DESCRIPTION:

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY:

EXPECTED STUDENT CONSTRUCTIONS:

EXPECTED GROUP INTERACTIONS:

PHASE 2: DEFINE

In the "define" phase students define (narrow down / converge) certain features of the final artifact based on the information explored in phase 1. This involves, for example, setting criteria, making decisions and deciding on specific features. In this phase, they can use the Exten(DT)2 technologies to ideate and conclude the basic

[2] Based on the 4Ds or Double Dimond model of Design Council https://www.designorate.com/the-double-diamond-design-thinking-process-and-how-to-use-it/

criteria and characteristics for their artifact e.g. define the core mechanics of their game or the gaming idea) or define the material and type of their 3D model.

DURATION: *e.g. 2 hours*

DESCRIPTION:

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY:

EXPECTED STUDENT CONSTRUCTIONS:

EXPECTED GROUP INTERACTIONS:

PHASE 3: DEVELOP

In the "develop" phase students are encouraged to give different answers (diverge again) to the initial problem by designing in their group a range of rapid prototypes for their artifact, testing and redesigning them until a final version is ready. This involves, for example, creating low-fidelity game prototypes, testing in the group while developing, and exchanging prototypes with other groups. It is quite possible that this phase would lead to an iteration through the first two phases (discover and define) as well. In this phase, they can use the Exten(DT)2 technologies to develop a range of demos, test them, share them with other students or online and keep redesigning them until they reach a final product.

DURATION: *e.g., 3 hours*

DESCRIPTION:

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY:

EXPECTED STUDENT CONSTRUCTIONS:

EXPECTED GROUP INTERACTIONS:

PHASE 4: DELIVER

In the "deliver" phase students focus on (converge) their final solution and its delivery to the target audience and the public. This involves making the final decisions to finalize it, presenting and demonstrating the final product to potential users, and developing promotional material (e.g. posters, pitch videos). In this stage they can use Exten(DT)2 technology, e.g. nQuire, to create online surveys sharing their final product with the target audience (e.g. other students, teachers, parents) and asking them to evaluate it, giving them feedback.

DURATION: *e.g., 1 hour*

DESCRIPTION:

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY:

EXPECTED STUDENT CONSTRUCTIONS:

EXPECTED GROUP INTERACTIONS:

5. STUDENT ASSESSMENT

Provide some suggestions for procedures, methods and tools that can be used by the teacher to facilitate the assessment of the learning outcomes stated at section 3.1. (e.g. post activity tests, reflective videos, student worksheets etc.).

TOOLS

Describe the assessment tools that will be used

e.g. student evaluation sheet, tutor's notes with a template for evaluating student activity, student worksheet

PROCEDURES & METHODS

Describe the assessment methodology that will be followed

e.g.1 Group evaluation. Each group of students fill in the worksheets during all phases and deliver them to the teacher by the end of the activity.

e.g.2 Individual evaluation. Each student keeps a personal diary which is evaluated at the end of the project. Additionally each student does a test after the end of the activity.

4. Activity Plans Examples

4.1 Overview of the Examples

To exemplify the functionality of the Activity Plan template to involved stakeholders, we considered it useful to design and provide examples of how the DT Activity Plan could be used in practice, through a number of examples. Specifically, NKUA researchers together with educators designed four Activity Plans as examples of DT cases to be implemented in the classroom (Table 1). The aim was to showcase a range of possible DT projects and technologies. Attention was paid to include in the examples different cases of, a) the topic of the DT project and the subjects it aligns with, b) the technologies used, and c) the grade of targeted students. The examples refer to the current version of the project technologies, since their extension with ET will be informed by insights from the pilot interventions in Year 1. In each of the examples, students use one of the project's digital authoring systems (ChoiCo, MaLT2, SorBET) together with the nQuire platform to create a digital artifact as the product of a DT project.

Table 1: Overview of the DT Activity Plans Examples designed by NKUA researchers and educators.

	Activity Plan Title	Technology Used	DT Issue	Final DT Project Product	Other Student Digital Productions
1	Ecological Footprint and Food Consumption Game	ChoiCo	The sustainability of food production and consumption	An online simulation game for young adults, developed in ChoiCo	Two nQuire surveys, a modified game, a game mockup and game rapid prototypes, presentation material
2	Biodegradable… jewelry	MaLT2 & 3D printing	Biodegradable materials in jewelry production	3D-printed jewelry for their older classmates and young adults designed in MaLT2	Two nQuire surveys, a number of 3D shapes in MaLT2, presentation material
3	What do you choose to recycle?	SorBET	Environmental education in the context of proper recycling	An online sorting game for adults and family members developed in SorBET	Two nQuire surveys, a game mockup and game rapid prototypes, digital presentation
4	I am responsible … and digital!	ChoiCo	Education and awareness about digital responsibility	An online simulation game for primary school kids and parents, developed in ChoiCo	Two nQuire surveys, a google doc, a game mockup and game rapid prototypes, a presentation file

4.2. Ecological Footprint and Food Consumption Game

DESIGN THINKING ACTIVITY PLAN TEMPLATE

1. BASIC INFORMATION

PROJECT TITLE:

Ecological Footprint and Food Consumption Game

AUTHOR(S):

Marianthi Grizioti (Post-doc researcher/Computer Scientist), Christina Gkreka (Primary Teacher)

ISSUE:

The sustainability of food production and consumption

FINAL STUDENT PRODUCTION:

A digital simulation game in ChoiCo (http://etl.ppp.uoa.gr/choico/) through which the players will learn about balanced diet and their ecological footprint through their daily diet. The target audience of the game would be young adults.

TECHNOLOGIES TO BE USED:

☐ MaLT2 ☒ ChoiCo ☐ SorBET ☐ VRobotics ☒ nQuire

DOMAINS:

Environmental Education 7/10, Balanced diet 9/10, Programming 7/10, Mathematics 3/10, Chemistry 4/10

2. SUMMARY

According to studies the ecological footprint is affected severely by the choices we make in our diet. Many people are unaware of what the ecological footprint is, due to a lack of information. In this DT project secondary school students (aged 15-16) are asked to think, design, develop and deliver a choice-driven simulation game about sustainable food consumption. The students have to first understand the topic, i.e. ecological footprint and balanced diet, empathize with the target audience, i.e. young adults, ideate about the game scenario, graphics, available choices and consequences, game mechanics etc., develop their game through repeated cycles of prototyping and testing and finally deliver their final game in a pitch presentation aimed at their target audience.

3. FOCUS, SET UP & REQUIREMENTS OF THE ACTIVITY

3.1 LEARNING OUTCOMES

Domain Related (for the domains mentioned in section 1)	Be able to explain the concept of ecological footprint and how it is affected by personal food consumption choices (Environmental Education)
	Be able to describe the relation between calories and weight gain/loss (Chemistry, Balanced diet)

	Be able to use the concept of proportional equations in the game values (Math)
(Emerging) Technologies Related	Be able to perform data handling in database, Map design, Programming of conditional structures and events
Design Thinking & innovation Related	Be able to empathize on the issue of ecological footprint, to perform iterative design, to communicate within the team and with young adults, to create rapid prototypes, to evaluate game instances, to present their final product
21st century Skills Related	computational thinking, collaboration, critical thinking

3.2 PARTICIPANTS & CONTEXT

STUDENTS

Age	15-16 years old
Prior knowledge	none
Nationality and cultural background	19 Greek students, 2 Albanian students, 1 Syrian student
Language	Greek
Special needs and abilities	1 student with dyslexia, 1 student ADHD

TIME

ACTIVITY DURATION: **10 hours**

IMPLEMENTATION DURATION: **5 weeks**

SCHEDULE: **2 hours (1 time)/week**

SPACE

ACTIVITY TYPE: ☒ In-person ☐ At distance ☐ Mixed

PHYSICAL SPACE: school computer laboratory

VIRTUAL SPACE: e-class, nQuire platform

3.3 SOCIAL ORCHESTRATION

POPULATION

NO OF STUDENTS: 22 NO OF GROUPS: 7 NO OF TUTORS: 1 NO OF ASSISTANTS: 1

STUDENT GROUPING & INTERACTIONS

Grouping Criteria	student preferences
Setting	6 groups with 3 students, 1 with 4 students, using 1 computer per group
Roles in the group	emergent roles decided by the students
Tutor(s) role(s)	intervene; monitor; facilitate

3.4 SUPPORTING ARTIFACTS & MATERIALS

Digital artifacts	A digital game called "Ecological Footprint" designed by the teacher in ChoiCo
Physical artifacts & material	student workbook, teacher observation notes
Supporting material	ChoiCo programming commands (digital), ChoiCo quick guide (printed), teacher instructions (printed)

4. IMPLEMENTATION -DESIGN THINKING ACTIVITY FLOW

This section describes how the teaching and learning process is expected to evolve through the 4 phases of the Design Thinking Methodology: Discover, Define, Develop and Deliver.

PHASE 1: DISCOVER

DURATION: **2 hours**

DESCRIPTION: Students first watch a video on food consumption. Then they login into the Exten(DT)2 platform and find the activity "Ecological Footprint Game '' where they play the ChoiCo game 'Ecological Footprint' designed by the teacher in order to understand the problem. Through the game, they access information on the ecological footprint of different foods. In parallel, they explore their own food habits through the choices they make in the game. They are asked to save the game log file, containing information about their choices and their consequences, every time they game ends. They will view these files later, to reflect on their food choices and how they affected the ecological footprint. Finally in order to understand their audience, i.e. young adults, they are asked to create and share an online survey in nQuire asking young adults about their daily food habits and preferences.

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY: In this stage, students are expected to use the technology in an exploratory way. They will play the game pre-designed by their teacher, discuss their scores and share ideas. They are also expected to use the nQuire platform to create an online survey for getting to know their audience

EXPECTED STUDENT CONSTRUCTIONS: Online survey in nQuire, a slightly modified game in ChoiCo

EXPECTED GROUP INTERACTIONS: Discussion on the topic, exchange of personal experiences

PHASE 2: DEFINE

DURATION: **2 hours**

SUMMARY (DESCRIPTION): In this stage, students access the results of the nQuire survey they shared in the previous stage and based on the responses they start ideating about their game within their group. They have to define an initial game scenario, game features and main mechanics based on the identified target audience's needs and issues (e.g. too much consumption of junk food). When they have decided the main

requirements and criteria for their game they login into the Exten(DT)2 platform and find the activity "Your game project". There they start creating the first mockup of their game in ChoiCo that depicts the main elements e.g. an indicative scene, 2-3 choices.

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY: Use ChoiCo in design mode to define the basic game elements (e.g. scenes, choice types, fields).

EXPECTED STUDENT CONSTRUCTIONS: A game plan (mockup) with basic elements defined.

EXPECTED GROUP INTERACTIONS: Ideate as a group to conclude in some first ideas, all students express ideas, best ideas are recorded in the ChoiCo.

PHASE 3: DEVELOP

DURATION: **4 hours**

DESCRIPTION: In this stage, students develop several game prototypes based on the criteria and requirements they have defined in the previous stage. They login into the Exten(DT)2 platform and continue the activity "Your game project". There, in the design mode of ChoiCo, they develop their game and by switching to the play mode they test and debug it. In the middle of the session, after some internal testing, they ask students from other groups to play their game while they keep observation notes and ask for their feedback. This will lead to further redesigns and improvements. Finally, they create an online survey on nQuire sharing publicly their final game and asking a wider audience, such as teachers, parents and young adults, to play it and give feedback through certain questions.

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY: Students are expected to develop many different game prototypes. They are expected to use ChoiCo's database, block-based programming and map design in conjunction in order to develop and improve their game. They are also expected to debug and fix their game algorithm, test it as players, create instructions and improve the overall gaming experience, keeping in mind the final user.

EXPECTED STUDENT CONSTRUCTIONS: At least 4 prototypes and 1 final game. A survey on nQuire.

EXPECTED GROUP INTERACTIONS: Collaborate for game development, exchange roles (developer, tester, instructor), interact with other groups to play their games.

PHASE 4: DELIVER

DURATION: **2 hours**

DESCRIPTION: Students create a presentation for their game that will target their audience, i.e. young adults. This can be a PowerPoint presentation, a poster or a pitch video (each group decides). When they are done they do an internal presentation in the classroom in which they show the promo material and do a demonstration of their game in ChoiCo. In this presentation, people from the targeted audience can be invited (e.g. teachers of the school, parents or older siblings). After the presentation, they receive feedback from participants who also vote for the best game. Finally, they share the promoting material and the game through nQuire to reach a larger audience asking for users to vote for their game with stars.

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY: Students are expected to use technologies for presenting and promoting their work. They will also use the nQuire platform to reach their audience with their final game and promo material.

EXPECTED STUDENT CONSTRUCTIONS: presentation material, nQuire survey.

EXPECTED GROUP INTERACTIONS: Collaboration for creating and performing the presentation,

5. STUDENT ASSESSMENT

TOOLS

Student worksheet, Student final games, final presentations, Teacher observation notes, Automated data collected by the ChoiCo tool for each group that will be accessed by the teacher in the Exten(DT)2 platform (e.g. time students programmed the game, times they pressed 'help' button, times and frequency of changing from play to design).

PROCEDURES & METHODS

Group assessment. Each group of students fills in a worksheet during all phases and delivers it to the teacher by the end of the project. The teacher will also evaluate the prototypes developed by each group throughout the activities to evaluate their learning and skill development in each DT stage.

4.3 Biodegradable… Jewelry

DESIGN THINKING ACTIVITY PLAN TEMPLATE

1. BASIC INFORMATION

PROJECT TITLE:

"Biodegradable… jewelry"

AUTHORS:

Katia Schiza (Math teacher, PhD Student), Maria-Stella Nikolaou (CS Teacher, PhD student)

ISSUE:

Biodegradable materials in jewelry production

FINAL STUDENT PRODUCT:

3D-printed jewelry designed by students in MaLT2 through which they will learn and become aware of the long-term environmental pollution and the need of using biodegradable materials in the construction of daily use products, such as jewelry. The target audience for the jewelry are their older classmates and young adults.

TECHNOLOGIES TO BE USED:

Select the Exten(DT)2 technologies that will be used by the students during the DT Project

☒MaLT2 ☐ChoiCo ☐SorBET ☐VRobotics ☒nQuire

DOMAINS:

Environmental Education 7/10, Mathematics 9/10, Programming 8/10, Chemistry 5/10.

2. SUMMARY

According to studies, most of the environmental damage that affects many ecosystems comes from human consumption. Whether this is food, water, gas, clothing, or jewelry, we are all consumers. The key is not to stop consuming, but to be conscious and sensitive about what we consume. Due to a lack of information, many people are unaware of the long-term environmental pollution and the impact of material choices in daily use objects on the environment.

In this DT project, secondary school students (aged 14-15) explore various ways to design, develop and deliver 3D-models of jewelry (e.g., earrings, necklace, bracelet) using MaLT2 https://etl.ppp.uoa.gr/malt2 and a 3D printer with biodegradable filaments. Firstly, the students have to understand the topic and define the situation/problem. (i.e., Why do we need environmentally biodegradable jewelry? What is the difference between biodegradable and non-biodegradable materials? How does the length of time it takes materials to degrade affect the environment?) In this phase, they also need to empathize with the target audience (i.e., older classmates and young adults). Next, they have to ideate about the jewelry that is to be created, its shape and structure, develop their jewelry model through repeated cycles of prototyping and testing, and finally deliver their final jewelry to their target audience.

3. FOCUS, SET UP & REQUIREMENTS OF THE ACTIVITY

3.1 LEARNING OUTCOMES

Domain Related (for the domains mentioned in section 1)	Be able to explain the concept of biodegradability and how the environment is affected by the material of the products that we all use in everyday life (Environmental Education).
	Be able to identify and explain the different materials degradation time and decide on which material to use for printing the 3D model. (Chemistry).
	Be able to identify, describe and use the mathematical properties of the 2D and 3D shapes needed for designing the digital jewelry model and also use spatial reasoning in a 3D digital environment (Mathematics).
(Emerging) Technologies Related	Be able to program with Logo, to use procedures (sub-procedures & hyper-procedures), conditional structures, and recursion.
Design Thinking & innovation Related	Empathize on the issue of long-term environmental pollution and the impact of material choices on the environment depending on degradation. Be able to implement an iterative design, create rapid prototypes and evaluate each model. Be able to present and communicate both within the team and with their target audience.
21st century Skills Related	Creativity, Computational Thinking, Critical Thinking, Collaboration.

3.2 PARTICIPANTS & CONTEXT

STUDENTS

Age	14-15 years old
Prior knowledge	Basic knowledge of programming concepts with Logo (but not necessarily needed)
Nationality, gender, cultural background	24 pupils from Greece 1 pupil from Albania 1 pupil from Egypt 12 boys & 14 girls
Language	Greek
Special needs and abilities	3 students with ADHD

TIME

ACTIVITY DURATION: 8 hours

IMPLEMENTATION DURATION: 4 weeks

SCHEDULE: 4 times - 2 hours (1 time)/week

SPACE

ACTIVITY TYPE ☐ In-person ☐ At distance ☒ Mixed

PHYSICAL SPACE: Home, School Computer Laboratory & Classroom

VIRTUAL SPACE: E-class & nQuire Platform

3.3 SOCIAL ORCHESTRATION

POPULATION

NO OF STUDENTS: 26 NO OF GROUPS: 9 NO OF TUTORS: 1 NO OF ASSISTANTS: 1

STUDENT GROUPING & INTERACTIONS

Grouping Criteria	Mixed school performance
Setting	8 groups of 3 students, 1 group of 2 students, using 1 computer per group
Roles in the group	Role exchange in the group
Tutor(s) role(s)	Intervene, monitor, facilitate

3.4 SUPPORTING ARTIFACTS & MATERIALS

Digital artifact(s)	E-class, Surveys on nQuire Platform
Physical artifacts & material	Student workbook, Teacher observation notes, 3D-printer & filaments
Supporting material	MaLT2 manual (digital), Teacher's instructions (printed)

4. IMPLEMENTATION - DESIGN THINKING ACTIVITY FLOW

This section describes how the teaching and learning process is expected to evolve through the 4 phases of the Design Thinking Methodology: Discover, Define, Develop and Deliver.

PHASE 1: DISCOVER

DURATION: **2 hours**

DESCRIPTION: At this first stage, flipped classroom approach will be utilized.
During their own time at home: Students are asked to watch a 3 minute video (uploaded to e-class by the teacher) about degradability and the different degradation times of some materials aiming to become aware that most jewelry is made from a slowly degradable material, causing long-term environmental pollution. In

order to "be connected" further with the problem, students are asked to search for more information about the time or the way different materials of products that we use every day degrade (e.g., iron, wood, gold, plastic) and upload them to a special discussion thread in e-class created by the teacher.
In class: After a short discussion about what students have watched in the video and what they found about the materials and their degradation time, students create and share an online questionnaire using the nQuire platform. This survey will help them understand and empathize with their target audience about the jewelry they like and use, such as the shape, size and type of jewelry (e.g. bracelets, earrings, necklaces), the frequency that they buy jewelry, and the material they are made of.

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY: In this stage, students are expected to use e-class in order to gather some information about biodegradable or not materials and nQuire to create an online survey in order to get to know their target audience and its habits or preferences.

EXPECTED STUDENT CONSTRUCTIONS: Online questionnaire on the nQuire platform.

EXPECTED GROUP INTERACTIONS: Discussion on the topic and exchange of personal experiences or any previous knowledge about degradation.

PHASE 2: DEFINE

DURATION: **2 hours**

DESCRIPTION: In this stage, students start ideating about their jewelry model based on the responses to the survey that they shared in the previous stage. Each group of students discusses the kind of jewelry that they will create (e.g. earrings, necklaces, bracelet) and continue by using the digital tool MaLT2. First, they open a microworld in MaLT2 where they can find existing codes, created by the teacher, that draw the basic 2D & 3D geometrical models on the scene (e.g., square, triangle, cylinder, pyramid). Then they experiment with the models (i.e., execute the code, dynamically manipulate the model, use the periscopic camera). Each team defines the model/s that is best for designing their jewelry, based also on the answers from the nQuire questionnaire. As part of this process, they modify the given model/s to create the appropriate models for their jewelry. For example, the teacher can give students a code that designs an incomplete cube which they have to complete to use it or an isosceles triangle to transform it into any kind of triangle they want for their jewelry. So, in this phase students have to define the kind of jewelry they will design, its design characteristics (e.g., earrings with two pyramids looking like a diamond and criteria of this jewelry) and its material criteria (e.g., use (or not) biodegradable filaments in the 3D-printed jewelry) based on the survey responses of the previous phase.

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY: Use MaLT2 programming environment in order to explore 2D and 3D models created by the teachers and modification of the codes in order to create useful models for their jewelry

EXPECTED STUDENT CONSTRUCTIONS: The modified 2D & 3D digital models in MaLT2.

EXPECTED GROUP INTERACTIONS: Discussion as a group to conclude with some first ideas about the piece of jewelry that they will design; communication and debate within each team on the modification of the codes of the models given by the teacher.

PHASE 3: DEVELOP

DURATION: **3 hours**

DESCRIPTION: In this stage, each team uses the online MaLT2 3D modeler to rapidly prototype complete 3D models of jewelry. They use the models they defined in the previous phase to create a bigger code that gives the complete 3D model of the jewelry. They may also "go back" to the "Define" phase, rethink the criteria of their jewelry, i.e., the basic shapes, and redefine them. During the design, students share their jewelry digital model by uploading it on the nQuire Platform and asking the other teams of their classroom and other students, teachers, or parents for their feedback. For instance, they could be asked to vote between two different jewelry designs, or to change a necklace's size with MaLT2 sliders and choose their preferred size in nQuire. Based on the feedback, students redesign and improve their model. When they finalize the 3D model, the students print the prototype with a 3D printer that uses biodegradable filaments.

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY: Students are expected to develop many different jewelry models as prototypes using the programming language of MaLT2 for designing their model, testing it, and improving it every time in order to satisfy their target audience. They will also use the nQuire platform to create a survey asking feedback for their jewelry.

EXPECTED STUDENT CONSTRUCTIONS: At least five prototypes and one final model of jewelry.

EXPECTED GROUP INTERACTIONS: Collaboration among the students of each group for the development of the piece of jewelry that they have chosen to create, interaction with other groups and other people for feedback and exchange roles among the role of developer, the role of tester and the role of the instructor during this stage.

PHASE 4: DELIVER

DURATION: **1 hour**

SUMMARY (DESCRIPTION): In the last stage, each group of students creates a presentation for its final product which can be a short video or a PowerPoint presentation, accompanied by the 3D printed jewelry. The groups are free to decide which one they go with. The presentation is made in the classroom where older students, who are their target audience, can also participate by giving feedback and voting for the best 3D model of jewelry. They also distribute prototypes of their jewelry to the school or their local community, gather feedback, and easily redesign and reprint their jewelry model if necessary. The last step for the students is to share their presentation and photos from their 3D printed models in the nQuire platform so that their work can be seen widely and be evaluated.

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY: Students are expected to use technologies in order to present and promote their final work and nQuire Platform to share their jewelry with their audience.

EXPECTED STUDENT CONSTRUCTIONS: Presentation of their jewelry and nQuire survey for evaluation.

EXPECTED GROUP INTERACTIONS: Collaboration for the presentation of their final model of jewelry; interaction with others students in or out class and on nQuire.

5. STUDENT ASSESSMENT

TOOLS

Students final 3D-model of jewelry (code on MaLT2 that constructs the model & physical printed model), student final presentation, student worksheets, student participation on e-class, teacher observation notes with a template for evaluating student activity, automated data collected by MaLT2 tool for each group of students that is assessed by the teacher in the Exten(DT)2 Platform.

Group assessment: Each group of students fill in the worksheets during all phases and deliver them to the teacher by the end of the activity. The teacher makes observation notes for each group during the activity concerning students knowledge, progress and understanding of the biodegradable jewelry issue. The notes can be further compared with those of other groups for analyzing students views and knowledge.

Individual assessment: Each student fills in an online questionnaire after the end of the activity (at home) on the degradation issue, mathematics and the way that they used the mathematical properties of the shapes in order to design an artifact in a programming environment, the collaboration within the team and generally the advantages or the difficulties of this D.T. project.

4.4 What do you Choose to Recycle?

DESIGN THINKING ACTIVITY PLAN TEMPLATE

1. BASIC INFORMATION

ACTIVITY TITLE:

What do you choose to recycle?

AUTHOR(S):

Maria-Stella Nikolaou (CS Teacher, PhD student), Ioanna Arambatzi (Math Teacher)

ISSUE:

Environmental education in the context of proper recycling

FINAL STUDENT PRODUCTION:

A digital sorting game in SorBET (http://etl.ppp.uoa.gr/sorbet/) through which the players will deal with the issue of recycling, getting knowledge about best practices, biodegradable and non-biodegradable materials and their after-use footprint on the planet. The target audience of the game are adults and family members.

TECHNOLOGIES TO BE USED:

☐ MaLT2 ☐ ChoiCo ☒ SorBET ☐ VRobotics ☒ NQuire

DOMAINS:

Environmental Education 10/10, Chemistry 6/10, Programming 3/10

2. SUMMARY

Despite the fact that actions of many organizations have caused alarm about global warming and the increasing ozone hole, many countries still emit a high percentage of pollutants while others mark very low rates of recycling and composting. Since we cannot intervene with industries production, we should at least strengthen the spirit of recycling and avoid non-biodegradable materials. In this DT project, secondary school students (aged 13-15 years old) who may think they already know enough about recycling, are asked to think, design, develop and deliver a sorting game on proper recycling practices. The students firstly have to understand the topic, i.e., impact of everyday waste in the ecosystem and the planet, rationality of different types of recycle bins, difference between biodegradable and non-biodegradable materials, why landfills are to be considered as a last resort in the waste hierarchy, etc. Secondly, students have to empathize with the target audience, i.e., adults with zero environmental awareness. This is done by creating a personal experience for students, through organizing waste picking in a nearby forest/ park, and/or observing daily habits related to recycling and waste. Next, students will ideate their game scenario, available materials, images being used, game mechanics etc., and develop their game through repeated cycles of prototyping and testing. Lastly, they will deliver their final game in a pitch presentation aimed at their target audience.

3. FOCUS, SET UP & REQUIREMENTS OF THE ACTIVITY

3.1 LEARNING OUTCOMES

Domain Related (for the domains mentioned in section 1)	Be able to explain the concept of waste, how it is affected by personal material choices and proper recycling practices (Environmental Education).
	Be able to explain what might affect how quickly something degrades and make predictions about the biodegradability of materials (Chemistry).
(Emerging) Technologies Related	Be able to perform data handling in SorBET's database, to add appropriate type of images, to program/use conditional structures and events if needed.
Design Thinking & innovation Related	Empathize on the issue of Global Warming, material waste and proper recycling materials. Iterative design. Communication within the team and with unaware adults. Rapid prototyping and evaluation of game instances. Presentation skills.
21st century Skills Related	Critical thinking, collaboration, problem solving, communication skills.

3.2 PARTICIPANTS & CONTEXT

STUDENTS IDENTITY

Age	13-15 years old
Prior knowledge	none
Nationality, gender, cultural background	21 Greek and Balkan students 13 boys & 8 girls
Language	Greek
Special needs and abilities	3 students with ADHD

TIME

ACTIVITY DURATION: **9-10 hours**

IMPLEMENTATION DURATION: **4 weeks**

SCHEDULE: **2-3 hours/week**

SPACE

ACTIVITY TYPE: ☒ In-person ☐ At distance ☐ Mixed

PHYSICA SPACE: School's computer laboratory, Local Park

VIRTUAL SPACE: E-class, NQuire platform

3.3 SOCIAL ORCHESTRATION

POPULATION

NO OF STUDENTS: 21 NO OF GROUPS: 7 NO OF TUTORS: 1 NO OF ASSISTANTS: 1

GROUPING & INTERACTIONS

Grouping Criteria	Based on teacher experience in classroom collaboration
Setting	7 groups of 3 students, using 1 computer per group
Roles in the group	1 driver (user of pc/keyboard), 1 observer (gives instructions), 1 secretary (keep notes of the process). All students cooperate and may be interchanged during the activity. The teacher will assign the initial roles
Tutor(s) role(s)	intervene, monitor, facilitate

3.4 SUPPORTING ARTIFACTS & MATERIALS

Digital artifacts	Surveys on nQuire, A digital game called “What do you choose to recycle?” designed by the teacher in SOR.B.E.T.
Physical artifacts & material	Student workbooks, personal mobile phones, teacher observation notes
Supporting material	SorBET quick guide (printed), teacher instructions (printed)

4. IMPLEMENTATION - ACTIVITY FLOW

This section describes how the teaching and learning process is expected to evolve through the 4 phases of the Design Thinking Methodology: Discover, Define, Develop and Deliver.

PHASE 1: DISCOVER

DURATION: **3-4 hours**

DESCRIPTION: Students first watch a video about the environmental crisis and the role of the recycling process. Then they login into the Exten(DT)2 platform and find the activity “What do you choose to recycle?” where they play the game designed by the teacher in order to understand that they themselves still are not totally aware of the proper discrimination of materials and their recyclability. Through the game, they start a conversation about the habits of the elder members of their families regarding recycling. In the next session, the activity embeds the personal experiences of students by organizing a short walk in a nearby park or grove, in order for everyone to understand the emergency of this real-world problem that concerns all of us, but mainly them as they are the new generation of this planet. During the walk they will be able to use their camera phones, take pictures of rubbish they find or recyclable objects in trash cans and upload them to a shared School Platform. On returning to the Lab, they access information on the recyclability of different materials and add them to the shared platform. Then they change parts of their game according to their point of view, e.g. add new objects or add a new recycling field, e.g. electronic devices. Finally, in order to understand their audience, i.e. older adults, they are asked to create and share an online survey on nQuire asking them about their daily recycling habits and questions to explore their knowledge over the issue.

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY: In this stage, students are expected to use the technology in an exploratory way. They will play the game pre-designed by their teacher, discuss their scores and share ideas. They are also expected to use nQuire to create an online survey to get to know their audience.

EXPECTED STUDENT CONSTRUCTIONS: Online survey in nQuire. Slightly modified game in SorBET.

EXPECTED GROUP INTERACTIONS: Discussion on the topic. Exchange personal experiences.

PHASE 2: DEFINE

DURATION: **2 hours**

SUMMARY (DESCRIPTION): In this stage, students access the responses of the online survey they shared in the previous stage and based on the responses, as the views and the awareness of the target group, they start ideating about their game within their team. For example, they may define the "falling" objects in the game based on the most popular answers to the question "what daily objects do you recycle?". When they have concluded some first characteristics that need to be included in their game they open the activity "Your game project" which loads an "empty" game in the Design Mode of SorBET. There, they start defining the elements of their game by creating a first mockup.

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY: Use SorBET. in design mode to define the basic game elements (e.g. objects and categories).

EXPECTED STUDENT CONSTRUCTIONS: A game plan (mockup) with basic game elements defined.

EXPECTED GROUP INTERACTIONS: Ideate as a group to conclude some first ideas, all students express ideas by argumentative discussions, debates and peer review, best ideas are included in SorBET.

PHASE 3: DEVELOP

DURATION: **2 hours**

SUMMARY (DESCRIPTION): In this stage students develop many prototypes of their game, based on the criteria and elements they defined in the previous stage, which they test and redesign. They login into the Exten(DT)2 platform and continue the activity "Your game project". There, they develop their game in SorBET and by switching to the play mode they test it. In the middle of the session, after some internal testing, they ask students from other groups to play their game while they keep observation notes and ask for their feedback. Finally they create an online survey on nQuire sharing publicly their final game and asking people to play it and give feedback through certain questions. The survey questions may concern both for the game content, e.g. "Do you agree with the classification of the falling objects in the game?", or for the game mechanics, e.g. "Rate from 1 to 5 the game difficulty". Based on their feedback they may redesign their game further.

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY: Students are expected to develop many different game prototypes. They are expected to use SORBET's database, and select and modify their objects using their images in order to develop and improve their game. They are also expected to test their game as players, create instructions if needed and improve the overall gaming experience, keeping in mind the final user.

EXPECTED STUDENT CONSTRUCTIONS: At least 3 prototypes and 1 final game, A survey on nQuire.

EXPECTED GROUP INTERACTIONS: Collaborate for game development, exchange roles (developer, tester, instructor), interact with other groups to play their games.

PHASE 4: DELIVER

DURATION: **2 hours**

SUMMARY (DESCRIPTION): Students create a presentation for their game that will target their audience, i.e. adults as their parents/relatives. This can be a PowerPoint presentation, a poster or a pitch video (each group decides). The material gathered from their own observations and experiences can equally be presented as an introduction to their argumentation. When they are done, they make an internal presentation in the classroom in which they show the promo material and make a demonstration of their game in SorBET. In this presentation, people from the targeted audience can be invited (e.g. teachers of the school, parents or older audience). After the presentation they get feedback from participants who also vote for the most efficient game, in terms of learning about recycling and at the same time being engaging and fun. Finally, they share the promoting material and the game through nQuire to reach a larger audience, asking for users to vote their game with stars. The winner will receive a prize, such as having their game published on the school or project website.

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY: Students are expected to use technologies for presenting and promoting their work. They will also use nQuire to reach their audience with their final game and promo material.

EXPECTED STUDENT CONSTRUCTIONS: Presentation material as a video/ poster / PowerPoint file, nQuire survey.

EXPECTED GROUP INTERACTIONS: Collaboration for creating and performing the presentation, the poster or the video.

5. STUDENT ASSESSMENT

TOOLS

Students worksheet, shared school platform with student observations, students final games, final presentations, teacher observation notes, automated data collected by SorBET tool for each group that will be accessed by the teacher in the Exten(DT)2 platform (e.g. times and frequency of changing from play to design, times they modify categories and objects).

PROCEDURES & METHODS

Group evaluation: Each group of students fill in worksheets during all phases and deliver them to the teacher by the end of the activity. The teacher will assess the procedure by taking into account all the aforementioned materials and discussing with the groups their experience after the end of the activity. Additionally, students will complete a questionnaire about their experience with the activity and what they think they have gained from the activity.

4.5 I am responsible… and digital!

DESIGN THINKING ACTIVITY PLAN TEMPLATE

1. BASIC INFORMATION

PROJECT TITLE:

"I am responsible … and digital"

AUTHOR(S):

Joanna Arampatzi (Math teacher, NKUA junior researcher)

TOPIC (THEME):

Education and awareness about digital responsibility

FINAL STUDENT PRODUCTION:

A digital game on the ChoiCo platform (http://etl.ppp.uoa.gr/choico/) concerning different aspects of digital responsibility. Through the design of a new game students are expected to familiarize themselves with the concepts of being digitally responsible, find a viable solution, and empower themselves as responsible citizens of a "phygital" society. The final users will be primary school kids and parents.

TECHNOLOGIES TO BE USED:

Select the Exten(DT)2 technologies that will be used by students during the DT Project

☐ MaLT2 ☒ ChoiCo ☐ SorBET ☐ VRobotics ☒ NQuire

DOMAINS: Citizenship (10/10), Programming (7/10), Mathematics (4/10)

2. SUMMARY

According to the Kaiser Family Foundation, people spend an average of 7.5 hours a day consuming media, and this does not include computer use for schoolwork. Technology is so pervasive it can be hard to put down the phone or turn off the laptop. But spending too much time with digital devices can be detrimental to personal relationships and even dangerous. Design Thinking educational projects can be a strong tool to raise awareness among kids from the early stages of their life in order to create digital responsibility literacy. In this Design Thinking project each group of secondary school students will design, develop and deliver a digital choice driven simulation game about 7 different main pillars of digital responsibility (*digital distraction, social media use, technology addiction, digital games, digital privacy, e-waste, environmental impact*). The game will target primary school students and parents with limited awareness or knowledge about digital responsibility. It is essential for the design students to fully comprehend the issue and its aspects and empathize with the addressed audience who may not be well informed about the risks that technology brings. The whole process of developing the games includes forming ideas about the construction of the game (interface, materials, programming, images etc.), creating rapid prototypes, testing and redesigning in a circular holistic perspective. By the end of this Design Thinking project the classroom can organize a workshop inviting Primary students and parents to attend and participate by playing and final products.

3. FOCUS, SET UP & REQUIREMENTS OF THE ACTIVITY

3.1 LEARNING OUTCOMES

Domain Related (for the domains mentioned in section 1)	• Be able to identify and explain the main perils concerning the extended use of technology and obsessive social media use (Citizenship). • Be able to recognize the impact that computers, mobiles and electronic devices have on health, environment, personal life and society at large (Citizenship). • Be able to use the concept of proportional equations in the game values (Mathematics).
(Emerging) Technologies Related	• Be able to program in ChoiCo environment (block – based programming, conditional programming structures, data handling), • Design or download appropriate types of images for ChoiCo maps.
Design Thinking & innovation Related	• Recognize the issue of excessive technology use, social media digital distraction, fishing, and data protection. • Communicate within the team. • Be able to create and test rapid prototypes.
21st century Skills Related	• Collaboration, Creativity, Critical Thinking, Information & Technology literacy, Computational Thinking.

3.2 PARTICIPANTS & CONTEXT

STUDENTS

Age	12-15 years old
Prior knowledge	none
Nationality, gender, cultural background	17 Greek students, 2 Albanian students, 2 Pakistani students, 10 boys & 11 girls
Language	Greek
Special needs and abilities	2 students with ADHD

TIME

ACTIVITY DURATION: **8 hours**

IMPLEMENTATION DURATION: **4 weeks**

SCHEDULE: **2 hours per week**

SPACE

ACTIVITY TYPE: ☒ In-person ☐ at distance ☐ Mixed

PHYSICAL SPACE: School's computer laboratory, classroom, School's Hall of events

VIRTUAL SPACE: Exten(DT)2 Platform, ChoiCo Environment, nQuire platform, Google Docs, Google Sheets, video making software (obs studio, PowerPoint etc.)

3.3 SOCIAL ORCHESTRATION

POPULATION

NO OF STUDENTS: **21** NO OF GROUPS : **7** NO OF TUTORS: **1** NO OF ASSISTANT(S): **1**

STUDENT GROUPING & INTERACTIONS

Grouping Criteria	Based on student criteria, and own willingness. Teacher intervenes if needed to facilitate the process.
Setting	7 groups of 3 students using 1 computer per group.
Roles in the group	Every member of the team equally contributes to the creation of the final product.
Tutor(s) role(s)	Teacher helps with the implementation of the scenario with a supportive, advisory and guiding role and also coordinates, organizes and assists when necessary.

2.4 ARTIFACTS & MATERIALS

Digital artifact(s)	Questionnaires on nQuire platform, Google doc worksheets, Online presentations
Physical artifacts & material	Workbooks, teacher observation notes
Supporting material	ChoiCo programming commands (digital), ChoiCo quick guide (printed), teacher's instructions (printed)

3. IMPLEMENTATION - DESIGN THINKING ACTIVITY FLOW

This section describes how the teaching and learning process is expected to evolve through the 4 phases of the Design Thinking Methodology: Discover, Define, Develop and Deliver

PHASE 1: DISCOVER

DURATION: **2 hours**

DESCRIPTION: In this first stage, students are asked to fill in a questionnaire created by the teacher on the nQuire platform regarding issues related to digital responsibility. In the questionnaire underneath every question there is a link related to the issue for gaining extra information. The teacher shares the results with the students, and they all discuss the principles that govern digital responsibility. Afterwards, they watch an introduction video regarding the dangers of the internet and its extensive use, and especially the negative effects it can have on younger children, but also on adults who do not have sufficient knowledge on the issue. Through discussion and brainstorming, the students together with the teacher arrive at specific thematic units of digital responsibility for their DT projects. Each group of students work on one unit for their project. For each topic, extensive research must first be done on the issue itself but also on the effects and influences it has on young children and parents, the target audience. To achieve this, students conduct research online and upload their findings to an online document shared within the group. Moreover, they create a study on nQuire, based on the questionnaire they filled in before, which they will distribute to their younger siblings, friends or parents to get more information in order to empathize and understand the shortcomings and needs of end users. For instance, they may ask them about the sites they visit the most, or whether they share personal information through the internet. At the end of the phase, the students of

each group play an online ChoiCo game, uploaded by their teacher on the Exten(DT)2 platform, to get familiar with the ChoiCo tool.

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY: In this stage, students are expected to use the technology in an exploratory way (ChoiCo Environment, nQuire Platform). They will use the nQuire platform by filling in an online survey to get to know the issue and then they will create their own survey to understand their audience. They will also play an online ChoiCo game, discuss their scores and share ideas.

EXPECTED STUDENT CONSTRUCTIONS: Annotations on Google docs, nQuire Study.

EXPECTED GROUP INTERACTIONS: Discussion about the topic and establish the role of each member, express personal opinions.

PHASE 2: DEFINE

DURATION: **2 hours**

DESCRIPTION: In this stage the students use all the data they have collected from the questionnaires and the internet research of the previous stage and start to form ideas regarding the game they will create for primary school children or adults. Depending on the answers to questions like, "How often do you share your location in the social media" or, "How many instagram friends do you have that you don't know in person?" Students can define the choices they will put into their game interface e.g. "share my location" or the game fields that these choices will have consequences on e.g. "personal data". More specifically, they collaboratively decide the outline of the game, what the features of the game will be, the fields on the map, whether the map will be semantic or real, as well as the variables that will be affected by the options and points on the map. They annotate their findings on a shared Google doc.

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY: Use ChoiCo in design mode to define the basic game elements (e.g. scenes, choice types, fields)

EXPECTED STUDENT CONSTRUCTIONS: Annotations on an online doc about ideating the initial designs, a game plan (mockup) with basic elements defined.

EXPECTED GROUP INTERACTIONS: Express ideas, share thoughts about the formation of the game and its characteristics, define roles within the group if needed.

PHASE 3: DEVELOP

DURATION: **4 hours**

DESCRIPTION: In this stage, each group develops their game on ChoiCo based on the characteristics and the game plan they had defined in the previous stage. In ChoiCo design mode they enter the numerical values of the variables of each field, choose mathematical relationships that may govern these variables, and develop strategies to achieve this goal. These values should somehow correspond as much as possible to reality and to the end users needs (e.g. their misconceptions about internet safety). The students create a game, compose it programmatically and mathematically to match the criteria of the social problem and constantly play and check for any errors, game problems and failures. At the same time, they can draw pictures or maps to place the game choices on them. Roles within the group are constantly rotated as students are asked to become designers, players and controllers of the game itself throughout the phase. In the middle of this stage, students upload the game prototype to the nQuire platform, ask their classmates to play with them, identify errors and give feedback through a questionnaire. During this process the

students may need to go back to the previous stages to achieve the optimal solution and give the game the optimal features. By the end of this stage they will have designed several game prototypes and one final game.

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY: Students are expected to take on the role of designer as well as players of a digital game with full access to the functionalities of the ChoiCo game creation environment. They are expected to create various rapid prototypes, review, edit and redesign the initial games they created with the end user's needs in mind.

EXPECTED STUDENT CONSTRUCTIONS: ChoiCo games (Rapid prototypes and final game), nQuire questionnaire.

EXPECTED GROUP INTERACTIONS: Communicate and collaborate within the team to develop and create a game as well as with other teams to review their games.

PHASE 4: DELIVER

DURATION: **2 hours**

SUMMARY (DESCRIPTION): In the last phase, the students will organize with the help of their school, an event to which they will invite students from lower elementary grades as well as their parents. In a shared file of presentations, each team will briefly and comprehensively make a few slides presenting the thematic unit they have undertaken, but also their game to the public. Everyone present will play the games, ask questions and be able to evaluate the material of each team. At the end there will be a vote for the best game with two prizes, one for the young children and one for the parents. At the end, the teacher gives a questionnaire to the audience, which will be used as a criterion for student assessment.

EXPECTED USE OF EXTEN(DT)2 TECHNOLOGY: Use technology to present their work to the final users and facilitate them when they are going to play their game.

EXPECTED STUDENT CONSTRUCTIONS: Presentation

EXPECTED GROUP INTERACTIONS: Communication and collaboration in order to make a creative presentation to draw audience attention and (optionally) also a video. Public presentation skills and development of marketing strategies.

4. STUDENT ASSESSMENT

TOOLS

Assessment materials

Students worksheets, Students final games, Teacher observation notes, nQuire questionnaires, Audience Vote.

PROCEDURES & METHODS

Group assessment & Individual assessment

Group assessment: At the beginning, each group will be given a document by the teacher regarding the analysis of the activities and the methods followed. At each stage and phase students will fill in everything they have done in detail. The document, the final game, the file of the presentation as well as the questionnaire

and data that will be collected from the use of the tool during the phase of the creation of the game and its modification (number of modifications, change of programming commands, fields on the map, etc.) and user voting function will be used as evaluation criteria for the work of each group.

Individual assessment: At the individual level, assessment results from the contribution of each student to the group based on teacher observation notes Additionally, at the end of the group worksheet, each student will write a paragraph reflecting om the experiences, benefits and difficulties they have faced through the project.

5. Next Steps

The first version of the "DT Activity Plan Template" discussed in this deliverable will be used as a design and reflection tool for DT activities.

In the following months (M7-M14) the following activities will take place:

- In-service teachers together with Exten(DT)2 researchers will use the DT Activity Plan Template to co-design Design Thinking activities (Activity Plans), through a series of co-design workshops organized as part of WP3 and WP5 (M6-M7).
- During these workshops we will collect data and feedback from the teachers on the structure and usefulness of the DT Activity Plan Template document. This will be done by keeping a facilitator's reflection diary in each workshop, asking teachers some feedback questions at the end of each workshop and having open-ended interviews with them at the end of all workshops (M6-M7).
- The in-service teachers will implement the created Activity Plans with their students in Year 1 pilot school interventions (M7-M10).
- During and after the interventions, teachers will reflect on the implementation of the Activity Plans in real school settings aiming to identify possible challenges, obstacles or opportunities, using a reflection sheet and through interviews. These data will be analyzed in WP7 (M8-M10).
- In parallel, the DT Activity Plan Template will be used as teaching material in professional development courses (WP6) with in- and pre- service teachers. Teacher feedback and data will also be collected during the courses (M8-M10).
- We will evaluate all the collected data from teacher co-design workshops, school interventions and professional development courses as part of the project evaluation (WP7) (M10-M12).
- Based on the results from the data analysis we will improve the DT Activity Plan Template document and the Activity Plans co-designed by the teachers, to be used in the second year of the project (M12-M14).

Glossary

Authoring System	A digital tool that enables non-technical users, e.g. teachers and students, to create and share digital artifacts (e.g. a game, a model) by using high-level computational affordances.
ChoiCo	(Abbr. Choices with Consequences). One of the project technologies. A web-based Authoring System that allows non-technical users to play, modify and create choice-driven simulation games using map design, an interactive database and block-based programming.
MaLT2	(Abbr. Machine Lab Turtlesphere 2). One of the project technologies. A web-based Authoring System that allows non-technical users, e.g. teachers and students, to design dynamically manipulated 3D models using a Logo-based programming language.
nQuire	One of the technologies used by the project - it is used to scaffold the process of designing and managing research studies (nquire.org.uk) supporting stage of design thinking such as Empathise.
School Intervention	An empirical study implemented in school context, during class or as an after-school activity. In Exten(DT)2 school interventions, participant students working in groups implement a Design Thinking Project. The aim of the intervention is to explore the Exten(DT)2 research question.
SorBET	(Abbr. Sorting Based on Educational Technology). A web-based Authoring System that allows non-technical users, e.g. teachers and students, to play, modify and create classification games using an interactive database and block-based programming.

References

Ackermann, E. (2001). Piaget's constructivism, Papert's constructionism: What's the difference. *Future of learning group publication*, 5(3), 438.

Al-Zebdyah, S. W. A. D. (2022). English Language Teachers' Perceptions about Design Thinking. *Journal of Curriculum and Teaching*, 11(*4*), 97-107.

Carroll, M., Goldman, S., Britos, L., Koh, J., Royalty, A., & Hornstein, M. (2010). Destination, Imagination and the Fires Within: Design Thinking in a Middle School Classroom. *The Journal of Academic Development and Education*, 1.

Dickson, B., Weber, J., Kotsopoulos, D., Boyd, T., Jiwani, S., & Roach, B. (2021). The role of productive failure in 3D printing in a middle school setting. *International Journal of Technology and Design Education*, 31, 489-502.

Glen, R., Suciu, C., Baughn, C. C., & Anson, R. (2015). Teaching design thinking in business schools. *The International Journal of Management Education*, 13(*2*), 182-192.

Goldman, S., Kabayadondo, Z., Royalty, A., Carroll, M. P., & Roth, B. (2014). Student teams in search of design thinking. In *Design Thinking Research* (pp. 11–34). Springer.

Kafai, Y. B., & Burke, Q. (2017). Computational participation: Teaching kids to create and connect through code. In Emerging research, practice, and policy on computational thinking (pp. 393-405). Springer, Cham

Kynigos, C. (2015). Constructionism: Theory of learning or theory of design?. In *Selected regular lectures from the 12th International Congress on Mathematical Education* (pp. 417-438). Cham: Springer International Publishing.

Kynigos, C., Grizioti, M., & Gkreka, C. (2018). Studying real-world societal problems in a STEM context through robotics. arXiv preprint arXiv:1806.03245.

Örnekoğlu-Selçuk, M., Emmanouil, M., Grizioti M., & Van Langenhove, L. (2022). Game Modding for Learning Design Thinking on an E-Learning Platform. *Designs for Learning*, 14(1), 99–111. DOI: https://doi.org/10.16993/dfl.181

Panke, S. (2019). Design thinking in education: Perspectives, opportunities and challenges. *Open Education Studies*, 1(*1*), 281-306.

Papert, S. (1980). Mindstorms: Children, computers, and powerful ideas. Basic Books, Inc.

Stith, K. M., Potts, M. L., DaVia Rubenstein, L., Shively, K. L., & Spoon, R. (2020). Perceptions of K-12 teachers on the cognitive, affective, and conative functionalities of gifted students engaged in design thinking. *Journal of STEM Teacher Education*, 55(*1*), 5.

Voogt, J., & Roblin, N. P. (2010). 21st century skills. *Discussienota. Zoetermeer: The Netherlands: Kennisnet*, 23(03), 2000.

Yiannoutsou, N., Nikitopoulou, S., Kynigos, C., Gueorguiev, I., & Fernandez, J. A. (2017). Activity plan template: a mediating tool for supporting learning design with robotics. In *Robotics in Education: Research and Practices for Robotics in STEM Education* (pp. 3-13). Springer International Publishing.

Wing, J. M. (2008). Computational thinking and thinking about computing. *Philosophical Transactions of the Royal Society*