

**Deliverable Report**



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**Deliverable 1.2**  
 Initial Data Management Plan

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Exten(DT) <sup>2</sup> identifier	D1.2 Initial Data Management Plan (DMP)
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## Table of Contents

<b>Abbreviations</b> .....	<b>3</b>
<b>List of Figures</b> .....	<b>5</b>
<b>List of Tables</b> .....	<b>5</b>
<b>1 Summary</b> .....	<b>6</b>
1.1 Background .....	6
1.2 Roadmap.....	6
<b>2 Introduction</b> .....	<b>7</b>
2.1 Project Objectives.....	7
2.2 DMP Objectives .....	8
2.3 DMP Relationship to Other Exten(DT) <sup>2</sup> Deliverables .....	9
<b>3 Data in Exten.(D.T)<sup>2</sup></b> .....	<b>10</b>
<b>4 FAIR Data</b> .....	<b>13</b>
4.1 Making Data Findable, Including Provisions for Metadata .....	13
4.2 Making Data Accessible .....	13
4.3 Making Data Interoperable.....	15
4.4 Increase Data Re-use .....	16
<b>5 Other Research Outputs</b> .....	<b>17</b>
<b>6 Allocation and Management of Resources</b> .....	<b>19</b>
6.1 Joint Data Controller Agreement .....	19
6.2 Accounts Related to the Project.....	19
6.3 Deployment Strategy.....	20
<b>7 Data Security and Storage</b> .....	<b>21</b>
<b>8 Ethical Considerations</b> .....	<b>25</b>
8.1 Privacy and Data Sharing and Long-term Preservation .....	25
8.2 Initial Ethics Board Report and Interaction with the Ethics Advisory Board .....	25
<b>References</b> .....	<b>26</b>
<b>Appendix A: Stakeholders and Associated Dissemination Activities</b> .....	<b>27</b>
<b>Appendix B: Educational Tools Technical Requirements (Malt2 Requirements)</b> .....	<b>30</b>
<b>Appendix C: Educational Tools Technical Requirements (SorBET Requirements)</b> .....	<b>31</b>
<b>Appendix D: Educational Tools Technical Requirements (ChoiCo Requirements)</b> .....	<b>32</b>
<b>Appendix E: Educational Tools Technical Requirements (ALA Requirements)</b> .....	<b>33</b>
<b>Appendix F: Educational Tools Technical Requirements (nQuire Requirements)</b> .....	<b>35</b>

## Abbreviations

Abbreviation	Full Name
3D	Three Dimensional
AI	Artificial Intelligence
ALA	Authorable Learning Analytics
AR	Augmented Reality
AWS	Amazon Web Services
ChoiCo	Choices with Consequences
DOA	Description of Action
DPO	Data Protection Officer
DT	Design Thinking
EAB	Ethical Advisory Board
ET	Emerging Technology
EU	European Union
Exten(DT) <sup>2</sup>	Extended Squared
FAIR	Findable, Accessible, Interoperable, and Reusable
GDPR	General Data Protection Regulation
HTML5	Hypertext Markup Language version 5
JWT	JSON Web Tokens
LA	Learning Analytics
LNU	Linnaeus University
MaLT2	MachineLab Turtleworlds2
NKUA	National and Kapodistrian University of Athens
NTNU	Norwegian University of Science and Technology
OMT	Operational Management Team

OU	The Open University
RDBMS	Relational DataBase Management System
SIEM	Security Information and Event Management
SIMPLE	SIMPLE – SME
SMILE	Smart Interactive Learning Ecosystem
SorBET	Sorting Based on Educational Technology
TCD	Trinity College Dublin
UCL	University College London
UGent	Ghent University
VPC	Virtual Private Cloud
VPN	Virtual Private Network
VPS	Virtual Private Server
WP	Work Package
XML	eXtensible Markup Language

## List of Figures

Figure 1. The Exten(DT) <sup>2</sup> approach to a sustainable digitalisation of education .....	7
Figure 2. The Exten(DT) <sup>2</sup> framework and its WP deliverables .....	9

## List of Tables

Table 1. Generated data and format type .....	11
Table 2. VM specifications .....	22
Table 3. Data generated from different account types .....	23

# 1 Summary

## 1.1 Background

A Data Management Plan is a document specifying how research data will be handled both during and after a research project. It identifies key actions and strategies to ensure that research data is of a high-quality, secure, sustainable, and – to the extent possible – accessible and reusable.

The Data Management Plan (DMP) for the Exten(DT)<sup>2</sup> project has been written following the document “Guidelines on FAIR Data Management in Horizon 2021” (Version 1.0, 5 May 2021). This is the “Initial DMP” of the project and outlines how the research data collected will be handled during and after the project. An “Updated DMP” will be produced as D1.3 in M18 and a “Final DMP” as D1.4 in M36. This DMP is a living document: it has been created in the early stages of research and will be updated as indicated above during the project.

## 1.2 Roadmap

Section 2 provides an introduction of the role, purpose, and objectives of the Exten(DT)<sup>2</sup> project, as well as an explanation of the type of data and information it contains. Section 3 describes the Data in the project. Section 4 provides a detailed description of the Fairness (findability, accessibility, interoperability, and reusability) of data and metadata used in the project. Section 5 elaborates on how the research outputs from the project will be managed. In Section 6 an overview is given of the allocation and management of resources. Section 7 focuses on information related to data security and storage, while Section 8 briefly covers ethical considerations.

## 2 Introduction

### 2.1 Project Objectives

Exten(DT)<sup>2</sup> uses Emerging Technologies (ET) such as Artificial Intelligence (AI), Augmented Reality (AR), 3D Printing and Virtual Robotics to enhance the pedagogic value, sustainable digitisation, and potential for wide deployment of Design Thinking (DT). This project aims to show that DT with ET can make DT a more feasible, accessible, and inclusive approach for students and teachers. Also, the integration of ET in DT could preserve and expand DT at a dynamic, multifaceted, and immersive scale. The target groups for this project are students and teachers at K-12 educational level.

As shown in Figure 1 the project will leverage some expressive media technologies to implement, monitor, and evaluate DT projects of K-12 with the aim of understanding how these technologies can support the development of students’ 21st century skills. This will in turn increase the scope, educational potential, and applicability of DT in mainstream schooling.

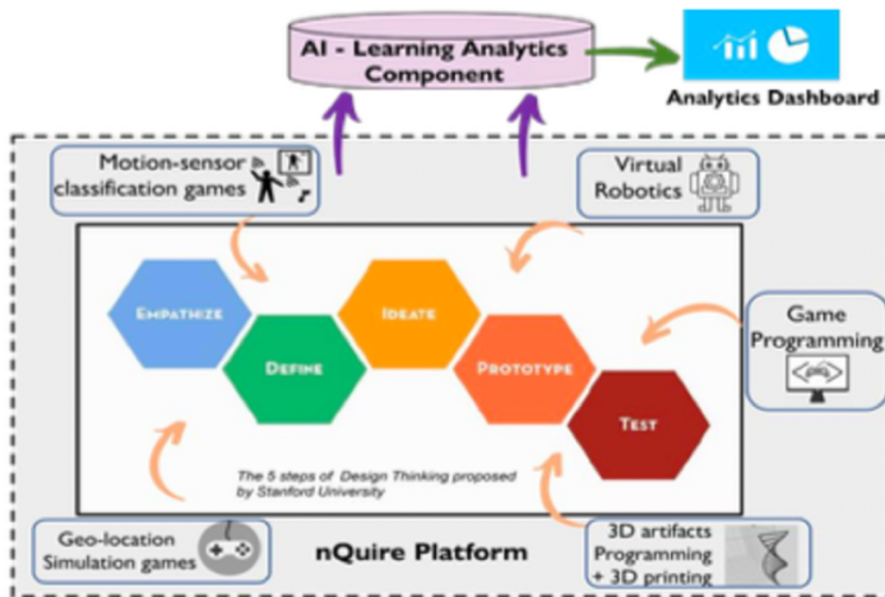


Figure 1. The Exten(DT)<sup>2</sup> approach to a sustainable digitalisation of education (Source: The Exten(DT)<sup>2</sup> project proposal)

The Exten(DT)<sup>2</sup> project will develop a platform based on SMILE (Smart Interactive Learning Ecosystem). This will provide the infrastructure for seamless integration and interoperability of components, logs user interactions, enables data processing, analysis, and visualization. The platform will also offer automated support system that enhances learning activities. UCL Knowledge Lab and Simple have collaborated to create SMILE, an educational initiative that incorporates innovative tools and technologies. These include MaLT2, SorBET, ChoiCo, VRobotics, and nQuire:

- (a) MaLT2 (MachineLab Turtleworlds2) is an open-source tool that allows users to express mathematical concepts through programming and create 3D dynamic models. It is built using JavaScript, HTML5, jQuery, and Bootstrap 5, and relies on two third-party libraries (Three.js for creating 3D graphics and codemirror.js for the programming editor component).
- (b) SorBET (Sorting Based on Educational Technology) is a web-based tool that allows users to play and create Tetris-style sorting games where users score points by directing falling elements into the correct container. It is built using JavaScript, HTML5, jQuery, and Bootstrap 5, with the addition of one third-party library called ML media pipe1 that uses machine learning for body tracking.
- (c) ChoiCo (Choices with Consequences) is an online, open-source tool that allows users to play, create, and modify choice-driven simulation games that deal with complex, real-life issues. The tool is web-based and built using JavaScript, HTML5, jQuery, and Bootstrap 5, along with two third-party libraries: leaflet.js for the GIS map editor and Blockly.js for the block-based programming workspaces.
- (d) Research has shown that virtual robotics can be an effective way to teach students about kinematics and improve their critical thinking and problem-solving skills (Alsoliman, 2022; Gonz.lez-Garc.a et al. 2020; Mistretta, 2022). However, technical integration issues have been encountered with the Cyberbotics platform, which has been considered for use in this project. Therefore, alternative VRobotics technologies are being sought that can be integrated with the Exten(DT)<sup>2</sup> system.
- (e) The Open University UK has created and maintains nQuire, a web-based platform for community and citizen science ([nquire.org.uk](http://nquire.org.uk)). Also, a student version has been created for this project, named "nQuire for students" and it can be accessed here: [learn.nquire.org.uk](http://learn.nquire.org.uk). It allows anyone to design, manage, and share research studies, as well as participate in studies designed by others in innovative ways that promote learning and engagement. In this project, nQuire for students will be used by students and teachers to support specific stages of the design thinking process, such as designing studies to understand the needs of the target group they are designing for and sharing their final prototypes with end-users for feedback.

Detailed information about these platforms can be seen in the Appendix section. It is important to note that the VRobotics platform referenced in this project is currently in the research phase, so there is only limited information available at this time. However, as the project moves forward, we anticipate being able to share more details and insights about this platform.

## 2.2 DMP Objectives

This DMP describes the data used in this project, how it is archived, preserved, and shared. It further provides a description on how data is treated before being uploaded in the database. Some other important DMP objectives related to the project include:

- Ensuring data quality: by addressing how data is collected and properly managed helps ensure data quality and accuracy.



- Facilitating data sharing and reuse: the DMP will make it easier for others to access and use data generated by the project.
- Complying with legal and ethical requirements: the DMP will set out how deliverables comply with relevant laws and regulations related to privacy and security of collected data, as well as ethical considerations related to the use of human subjects or sensitive data.
- Managing data effectively: the DMP will help project team members manage data effectively, by outlining data processes, backup, archiving, and importantly retrieval.
- Enhancing project transparency: data management processes will be covered in the DMP and will increase transparency around the methods, and procedures used. This will increase confidence in the project's results.

### 2.3 DMP Relationship to Other Exten(DT)<sup>2</sup> Deliverables

The relationship of DMP to other Work Packages (WPs) is dependent on the project and how data management fits into the overall project plan. In this project, all WPs are interrelated from WP1 - collection, dissemination, and management of financial and other useful information; WP2 - reporting and reviewing theoretical frameworks; WP3 - co-design of educational resources and materials; WP4 - shaping technologies (technical specification for DT platform LA, AR, and 3D); WP5 - school interventions; WP6 - professional development; WP7 - project evaluation; WP8 - dissemination and spreading of stakeholders' data on legal basis; and WP9 and ethical considerations WP9. The relationship of these WPs is further illustrated in Figure 2 below.

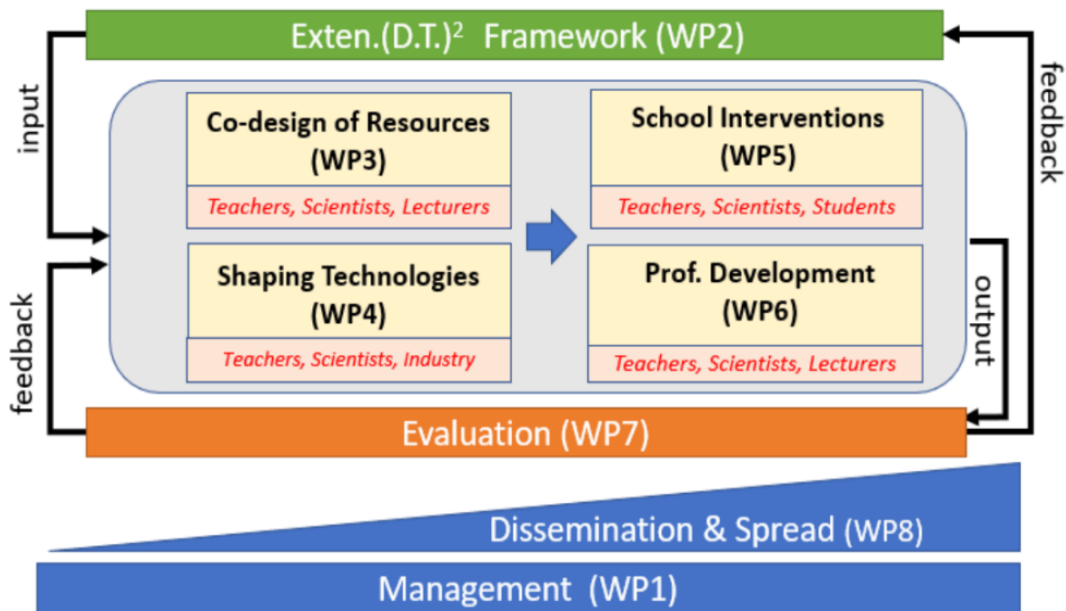


Figure 2. The Exten(DT)<sup>2</sup> framework and its WP deliverables (Source: The Exten(DT)<sup>2</sup> project proposal)

### 3 Data in Exten(DT)<sup>2</sup>

This section covers data usability, data format, data size, relationship of data generated to the objective of the project, and its benefits to academic and non-academic stakeholders with similar interests.

The Exten(DT)<sup>2</sup> project will produce, utilize, distribute, and share a significant amount of varied data. These data will serve as support for educational and training purposes. Also, it will serve as artifacts and derivatives of piloting and implementing different phases in the project. It is important to note that data will be manually or automatically generated. Additionally, data can be in qualitative or quantitative forms, depending on the source of data. Each dataset will have its own purpose. This means data will be organized in specific content (raw or processed data). The aim is to support the activities and aims of the project. The data will be from different sources such as participants in educational activities, researchers, project members, professionals, sensors, or other artifacts.

Data will follow different formats and standards due to its diverse nature and post-processing requirements. The project will provide all necessary infrastructure to facilitate integration and interoperability of components as well as the ability to intercept/log user interactions, allow processing, analyze, visualize data, and enhance learning activities with automated support, all of which will generate data. This will be based on the SMILE platform as discussed in Section 2.1.

Data-driven practices have become increasingly prevalent in education, although research has primarily focused on higher educational settings (Slade & Tait, 2019). However, concerns have recently arisen regarding the ethics and privacy of learning analytics (LA) and the need for stakeholders to understand data feedback. To address these concerns, the Exten(DT)<sup>2</sup> project seeks to involve stakeholders in the design process of LA from the outset, ensuring their ethical and privacy concerns are taken into account. This will require stakeholders to have a certain level of data and feedback literacy (Viber et al., 2021; Ifenthaler, 2020). This project will employ a participatory design such as Value Sensitive Design (VSD) approach, which integrates human values into technology design (Friedman et al., 2013). The VSD tripartite methodological approach will be used to incorporate stakeholder values and ethical reflections into the design of the Exten(DT)<sup>2</sup> platform. This approach involves conceptual, empirical, and technical investigations that engage stakeholders through activities such as workshops, interviews, and surveys.

The conceptual investigation will identify both direct and indirect stakeholders and elicit their values using appropriate methods that comply with global ethical guidelines in LA (Slade & Tait, 2019).

The empirical investigations will engage stakeholders in examining and evaluating their experiences with the technology in relation to the values they consider important. The technical investigations will allow stakeholders to reflect on how important values are either hindered or supported by the design. This iterative process will engage stakeholders throughout the design and development of the LA platform, ensuring that stakeholder values and considerations are incorporated from the outset.

The project has a broad target audience, including teachers, students, academics, policy representatives, industry organizations, other EU-funded projects and the public. Information about the project's activities and outcomes will be disseminated to these stakeholders. The effectiveness of these efforts will be measured using Key Performance Indicators (KPIs), target numbers, and contingency plans will be in place to ensure their success. Ultimately, the project aims to promote its activities and encourage relevant target groups (as outlined in Appendix A).

The following types of data and format, as highlighted in Table 1 will be generated and/or reused in year 1:

Table 1. Generated data and format type

<b>Data</b>	<b>Generation source and procedure</b>	<b>Data format and type</b>
Audio recordings	<ul style="list-style-type: none"> <li>• Interviews with adults and children</li> <li>• Action in the classroom involving adults and children</li> </ul>	Audio format (WAV, MP3)
Video recordings	<ul style="list-style-type: none"> <li>• Action in various classroom settings involving adults and children</li> </ul>	Video format (MP4, WMV, or MOV)
Screen recordings	<ul style="list-style-type: none"> <li>• Student and teacher screens</li> </ul>	Video format (MP4, WMV, or MOV)
Photographs	<ul style="list-style-type: none"> <li>• Objects and empty rooms</li> </ul>	Image format (JPEG, PNG, or PDF)
Observation notes	<ul style="list-style-type: none"> <li>• Action in various classroom settings involving adults and children</li> <li>• Digital documents in various formats such as Word</li> </ul>	Unstructured text format (Plaintext, PDF, or Doc Format)
Survey data	<ul style="list-style-type: none"> <li>• Anonymous and identifiable survey responses from adults and children</li> <li>• De-identified and anonymous survey results will be stored in Excel file formats</li> </ul>	Structured text format (Excel, or CSV)
Documents and physical artifacts of learning	<ul style="list-style-type: none"> <li>• Created by adults and children.</li> <li>• Digital documents in various forms</li> </ul>	Various formats (Text, Image, Audio or Video)
Digital artifacts of learning	<ul style="list-style-type: none"> <li>• Created by adults and children</li> </ul>	Game file format, 3D model format (obj)

In future versions of the DMP this table will be extended with a column to cover stakeholders. This will include information on who will have access to the different datasets. As the project moves forward involving stakeholders in the design of, e.g., the learning analytics and visualisations, data will be identified that is meaningful for different stakeholders. This means that the DMP will eventually contain a mapping of data and who has access to that data.

For example, this year NTNU through its work in WP2 collected some anonymous data for the background of the participants from a workshop held in Athens (i.e., paper and digital artifacts/sketches, anonymous surveys). This data will be used in the forthcoming WP2 deliverables. This is anticipated in year 2. Additionally, there will be data from the LA platform as the project progresses which will need to be addressed in in the next updated versions of the DMP.

Further data information related to the Exten(DT)<sup>2</sup> project are addressed in the form of Q and A below:

**Q: What is the purpose of Exten(DT)<sup>2</sup> data generation or re-use and its relation to the objectives of the project?**

A: The data generated for the evaluation will be used to inform the design of learning activities, resources, and digital tools in subsequent cycles of the project. It will also be used to evaluate the effectiveness of the interventions and the responses of students and teachers. Data will also be collected to inform the KPI of the project, support academic publications, and guide and support future work (see Appendix A).

**Q: What is the expected size of Exten(DT)<sup>2</sup> data that is intended to be generated or re-use?**

A: 5TB or more (this is an educated guess given that we are recording video data).

**Q: What is the origin/provenance of Exten(DT)<sup>2</sup> data, either generated or re-used?**

A: For the evaluation, data will be generated in naturalistic settings including schools and university classrooms as well as online classrooms hosted on e.g., MS Teams. It will include naturalistic data such as video recordings of the action, filtered data such as written observations and data generated through activities with participants such as surveys and interviews, specifically designed for the purpose of research.

**Q: To whom might Exten(DT)<sup>2</sup> data be useful ('data utility'), outside the project?**

A: Evaluation data will be useful to researchers working in similar areas, such as emerging technologies in education, teacher education and 21st century skills development. It may also be relevant to policy makers, for example for the integration of project-based learning in school curricula.

## 4 FAIR Data

FAIR principles have become increasingly common in the research community. These principles aim to make research data easy to find, understand, and use, especially for those who could benefit from it (Dunning, De Smaele, & Böhmer, 1970). To achieve this, it is essential to prepare and continue working with the data and metadata until it becomes accessible for users. This project aims to follow a systematic DMP to fully ensure the fairness of the data as much as possible. This will be achieved by providing adequate documentation and metadata that search systems can use to help secondary users locate materials.

### 4.1 Making Data Findable, Including Provisions for Metadata

Q: Will data be identified by a persistent identifier?

A: Yes, data will be identified by persistent identifiers.

Q: Will rich metadata be provided to allow discovery? What metadata will be created? What disciplinary or general standards will be followed?

A: Yes, the Dublin Core metadata standards will be used for all datasets, with disciplinary specific standards from Computer Science (CS) and Education applied as relevant. This will ensure that metadata is accessible:

<https://www.dublincore.org/specifications/dublin-core/dcmi-terms/#section-1>.

Q: Will search keywords be provided in the metadata to optimize the possibility for discovery and then potential re-use? Will metadata be offered in such a way that it can be harvested and indexed?

A: Yes, and yes. Providing search keywords in metadata is an important practice to optimize the possibility for discovery and potential re-use of research data. This will be achieved by including relevant and descriptive information about the data in the metadata, such as author, title, abstract, subject, and keywords. Additionally, metadata will be offered in a way that allows it to be harvested and indexed, making it easier for others to find and access data. By following these practices, research data will be more effectively shared and reused, contributing to the advancement of knowledge in various fields.

### 4.2 Making Data Accessible

All access to data will be based on the ‘least privilege principle’. This means that users and processes are only able to access information that they need to have access to.

Q: Repository: Will the data be deposited in a trusted repository with appropriate arrangements?

A: Yes, it will be deposited in Zenodo which is an open-access digital repository that provides researchers with a platform to store, share, and preserve their research outputs, including data sets, software, posters, preprints, and other scholarly works. Zenodo was created in response to the need for a universal, open-source repository that provides researchers with long-term access to their research data and publications, ensuring that they remain accessible and usable for future generations of scholars. It is a digital repository that accepts all types of research artifacts from any stage of the research lifecycle in all fields

of research. Depositors must have the appropriate rights and are allowed to retain ownership of their content. All file formats are accepted, and the repository is working on guidelines and features to encourage preservation-friendly formats. The maximum file size per record is 50GB, but higher quotas can be requested on a case-by-case basis. Users can deposit content under closed, open, or embargoed access and specify a license for all publicly available files. Use and reuse of data objects is subject to the specified license. Zenodo promises to retain items for the lifetime of the repository, which is currently linked to the lifetime of the host laboratory, CERN. The data files and metadata are backed up nightly and replicated into multiple copies in the online system. If the repository closes, best efforts will be made to integrate all content into suitable alternative institutional and/or subject-based repositories.

**Q: Does the repository ensure that the data is assigned an identifier? Will the repository resolve the identifier to a digital object?**

A: Yes, and yes, with reference to Zenodo: <https://about.zenodo.org/policies/>.

**Q: Data and Metadata: Will all data be made openly available?**

A: No, not all data will be openly available. Certain data, e.g., video data, images and audio recordings which include children or adults will not be made available to researchers for child protection purposes and privacy protection.

De-identified data will have access restrictions in place to ensure that only those with a legitimate interest which is within the scope of the original data generation, have access to the data, as required under ethical approval, if this is needed, and is considered appropriate.

Anonymous data will be made openly available. It can be open or embargoed with a maximum duration of 4 to 5 years.

**Q: If there are restrictions on use, how will access be provided to the data, both during and after the end of the project?**

A: Zenodo provides editable access controls for both during and after the project. If someone is interested in accessing the data, they will need to make an application through the repository which will be sent to the project leads at the relevant institutions, who will collectively decide about whether the request is in line with the scope of the project.

**Q: How will the identity of the person accessing the data be ascertained?**

A: Institutional email addresses, which can be verified through the institution's own website, will need to be used as the primary contact.

**Q: Is there a need for a data access committee (e.g., to evaluate/approve access requests to personal/sensitive data)?**

A: Given the multi-site data collection involved, yes. The Operational Management Team (OMT) which involves all WP and Partner leads will make such decisions where applicable.

Q: Will metadata be made openly available and licensed under a public domain dedication CCO, as per the Grant Agreement? Will metadata contain information to enable the user to access the data?

A: Yes, and yes.

Q: How long will the data remain available and findable? Will metadata be guaranteed to remain available after data is no longer available?

A: Metadata will remain available for the lifetime of Zenodo. Data will be available for at least 5 years after the project ends and longer if deposited in Zenodo. Under the FAIR Principles, all data (whether it can be accessed or not) will have metadata assigned to it.

Q: Will documentation or reference about any software needed to access or read the data be included? Will it be possible to include the relevant software (e.g., in open-source code)?

A: Yes, and yes.

Q: Will your data include qualified references to other data (e.g., other data from your project, or datasets from previous research)?

A: Yes, since some of the WPs share related information as detailed in section 2.3.

### 4.3 Making Data Interoperable

SMILE will serve as the basis for providing the necessary infrastructure to facilitate component integration and interoperability. It will have the ability to intercept and log user interactions, allowing for the processing, analysis, and visualization of data to enhance learning activities through automated support.

To achieve the interoperability goal, data will be documented and offered in standardized, open formats that can be easily accessed by APIs and other web services. This ensures that data can be easily integrated with other data and utilized by different applications for further exploration, analysis, or processing.

It is essential to verify that the vocabularies used in data or metadata are also FAIR (Findable, Accessible, Interoperable, and Reusable) to allow other individuals or machines to access, find, interoperate, and reuse them. The controlled vocabulary applied to describe datasets must be recorded and solvable through globally unique and persistent identifiers. This documentation must be effortlessly discoverable and accessible to all individuals who utilize the dataset.

Furthermore, metadata must contain appropriate references to other metadata. The objective is to establish numerous significant connections between (meta)data resources to enhance the contextual understanding of the data.

Data formats such as extensible Markup Language (XML), JavaScript Object Notation (JSON), Keyhole Markup Language (KML) for geo-location data, and comma-separated values (CSV) provide optimal performance and interoperability. It is crucial that the information is

provided in these formats since they are open standards and language-independent data formats. Additionally, this will help make data findable and accessible, which is essential to fostering greater interoperability.

The Dublin Core Metadata Initiative (DCMI) is responsible for maintaining and developing standardized metadata elements used to describe digital resources such as web pages, images, videos, and other types of digital content. SMILE utilizes these standards, and this will ensure that data is documented and described in a consistent and interoperable manner.

#### 4.4 Increase Data Re-use

Q: How will you provide documentation needed to validate data analysis and facilitate data re-use (e.g., readme files with information on methodology, codebooks, data cleaning, analyses, variable definitions, units of measurement, etc.)?

A: This will be done by clarification in documentation with for example terms and conditions covering how data will be shared and reused.

Q: Describe all relevant data quality assurance processes.

A: In addition to the principles and processes described in this and other sections of the DMP, each respective deliverable will describe its data. The information contained or provided within each respective deliverable will therefore reflect the data quality.



## 5 Other Research Outputs

In addition to the management of data (covering as part of WP1), partners will also consider and plan for the management of other research outputs that may be generated or re-used. Such outputs can be either digital (e.g., software, workflows, protocols, models, etc.) or physical (e.g., what happened in meetings etc.). Further Information is provided below for each of the WP2-WP8.

WP2 - The Exten(DT)<sup>2</sup> Framework: During the development of the different versions of the framework and the guidelines, different data may be collected to complement the input from the literature and the other WPs work. For the deliverable in the first year only anonymous data has been collected and include paper and digital artifacts/sketches that represent the initial versions of the Framework from workshop with educational researchers and/or teachers. The data also includes anonymous surveys for the background of the participants of the workshop and/or their opinions of the framework and guidelines together with written notes.

WP3 and WP5 - Co-design of Educational Resources and Materials and School Interventions: Activity Plans will be produced by teachers as part of WP3 and WP5. These are lesson plans in which teachers describe how they will implement an intervention with their students. No personal data is included, apart from the name of the teacher (as the plan creator), which is optional. The plan will be completed in the form of word documents for Year 1. For years 2 and 3 they will be in digital form, on the nQuire platform.

WP4 - Shaping Technologies: Other outputs include games or 3D models that teachers and students may develop or edit using the three digital learning tools (ChoiCo, MaLT2, and SorBET). These artifacts will be anonymous, and no personal data is to be included. In the case the researchers or teachers detect any personal data included into the digital artifacts e.g., student names or pictures they will remove them. Moreover, teachers and students may create studies using the nQuire platform, the SMILE platform and the authoritative learning analytics dashboard in WP4. A description of the technical requirements for these educational tools is covered in Appendices B-F.

WP6 - Professional Development: During professional development activities participant teachers may produce digital artifacts (games, 3D models) with the three learning tools (ChoiCo, MaLT2, and SorBET) as well as online surveys with the nQuire platform. This data will not include any personal information and may be used as research outputs or in dissemination activities.

WP7- Evaluation: Other research data that will be collected during school interventions include data for the evaluation. These involve tutor reflection after each session in the classroom, researchers' observation notes, students' pre and post surveys and interviews, screen/audio recordings and video recordings. This data will be anonymized, and parts of the anonymized transcribed data may be used in research outputs (deliverables, reports, papers, presentations etc). More details will be provided in D7.1 (Cycle 1 Evaluation Report due M12).

WP8 - Dissemination and Exploitation: A major aim is to ensure that the right stakeholders are reached at the right time; with and for the intended impact. Concerted efforts will be made to ensure all stakeholders are/will be provided with information that is tailored to their specific needs and addresses any questions or concerns they may have regarding benefits, effort, effectiveness, costs, feasibility, etc.

## 6 Allocation and Management of Resources

### 6.1 Joint Data Controller Agreement

Regarding data management, and in particular personal data, following the advice of LNU's Legal Adviser and DPO, a Joint Data Controller Agreement (JDCA) is being finalised. It is expected to be in place by the 30 June 2023.

The project's JDCA addresses how the partners will share responsibility for personal data processing. It outlines their respective responsibilities and how they will work together to comply with GDPR requirements and protect personal data. All partners will share information, including personal data, with each other for research purposes as stated in the Consortium Agreement (CA). Partners will only process personal data insofar as such processing is needed. The partners agree and acknowledge that it is rarely possible, before or at the start of personal data collection for research purposes, to completely identify the aim of such personal data processing. However, the partners will not, as far as possible, process personal data to a greater extent or for other purposes than stated in the CA. The partners agree that they are jointly responsible for the processing of personal data to take place under the CA and that the JDCA covers all processing of personal data within this framework.

### 6.2 Accounts Related to the Project

A high-level overview of the processes associated with each account type is described below:

- (a) The project's platforms (ChoiCo, SorBET, & MaLT2) require school administrators to register their schools and confirm their email to receive a password. Once logged in, the school administrators can register tutors and learners. The administrators can view tutor names and emails, but not their passwords, as well as the student names and unique identifiers. However, the platform does not store any IP information or timestamps for the sessions.
- (b) Tutors are sent an email invitation to confirm their email and receive their password. After logging in, they can begin developing learning materials and creating student groups to assign tasks to. However, tutors are not permitted to access information about other tutors teaching in the same school. They can view the names or aliases of their students to make decisions about how to allocate them to groups. Like the school administrators, the platform does not store any IP information or timestamps for the sessions.
- (c) Each learner is given a unique and secret passcode that they can use to access their learning tasks. To access their activities, learners need to use their passcode and the class ID they belong to. This method allows for easy access, anonymization of data, and security, without exchanging any personal or sensitive information. The user interface presented to the students does not display any personal information about them or other group members. As learners complete their activities, anonymized and timestamped interaction indicators are generated and stored in the database. However, no IP information is stored for the sessions.

- (d) System administrators and developers have unrestricted and direct access to user data. However, sensitive information stored in the database will be encrypted, which means that they will be unable to identify individuals, link them to usage data or reuse their passwords.

### 6.3 Deployment Strategy

This project will have a flexible deployment strategy that can accommodate different scenarios such as cloud or on-premises. The initial deployment will be on Amazon Web Services (AWS) due to its low cost of ownership and scalability. Cloud-based deployment eliminates the need to purchase hardware or software, and maintenance costs are low. The platform can easily scale up or down, and resources can be allocated or released quickly and efficiently. Overall, the platform aims to be adaptable to different project needs over time.

Regarding development and deployment, having a network of replicated resources that are easily accessible from anywhere will greatly enhance collaboration in software development. This improves maintainability, testability, and deployment efficiency, as outcomes are directly available for user testing.

Exten(DT)<sup>2</sup> chose AWS over other cloud providers because of its market dominance, ongoing collaboration with UCL, and the team's previous experience with the platform, thus making it a cost-effective option. Additionally, Amazon provided initial funding that will be sufficient to run the infrastructure for the first year of the project.

## 7 Data Security and Storage

Below are details of the provision in place for data security including data recovery as well as secure storage/archiving and transfer of sensitive data:

The backend infrastructure of the solution will be built entirely from the following services:

- (a) **API Gateway:** This will be utilized to develop and release APIs that will be utilized for all internal communications within the solution. The system will incorporate a Custom Authorizer function to validate that any incoming connections from front-end instances have been authenticated.
- (b) **Services:** The solution will use services that consist of small code modules responsible for carrying out different activities. These services are designed to be stateless, meaning that they do not store any data between instances when they are invoked.
- (c) **DBMS:** This is a Relational Database Service, in which the user data is stored.

All components will be contained within a Virtual Private Cloud (VPC).

- (a) **Protective Monitoring:** Depending on the platform used the system may be integrated with a Security Information and Event Management (SIEM) tooling.
- (b) **Operating System Hardening:** The solution will use virtual server instances within Amazon Web Services. These instances will use pre-built images of operating systems that come with built-in security measures to ensure protection from the outset. These images will be created by UCL's specialized IT support teams. Regular updates will be carried out during the project to ensure that the security measures remain effective.
- (c) **Patching:** As the solution will comprise virtual server instances continuous monitoring of security updates and patching will be necessary.
- (d) **Protection of Data-In-Transit:** All traffic flows from the front-end to the API Gateway, and all internal API calls within the solution will be encrypted using HTTPS.
- (e) **Protection of Data-At-Rest** All data in the system will be stored in the Relational Database System, which will have encryption enabled and managed by the Node-RED Key Management Service. This encryption will apply to data stored on the volume, database snapshots, automated backups, and read replicas. The credentials needed to make authorized API calls by the services will be stored as encrypted environment variables within Node-RED.
- (f) **Specifications** To ensure security, the initial deployment of the Exten(DT)<sup>2</sup> platform will include a Virtual Private Cloud (VPC) with a single subnet that is isolated from external networks for inbound connections. However, outbound connections will be permitted to utilize third-party services and for administrative flexibility if new software is needed. Initially, access will be granted through VPN, and once internal testing is completed, inbound access to selected networks can be allowed before releasing the platform to schools. This approach is both secure and easy to implement and maintain.

Table 2. VM specifications

VM spec for the application server	VM spec for the DBMS
vCPU: 8 Primary Storage (RAM): 16 (preferably 32) GB Secondary Storage (Disk1 - OS): 512 GB SSD R≈560MB/s, W≈520MB/s Secondary Storage (Disk2 - Data): 2 TB M.2 NVMe 1.4 R≈7000MB/s, W≈5500MB/s OS: Windows server 2019 or 2022	If this is provisioned as a service the underlying instance should be equivalent to t2.large AWSEC2 spec or higher.

Data will be safely stored in trusted repositories (See, for example, Section 4.2 covering Zenodo) for long term preservation and curation. Data generated through the evaluation of the co-creation, school intervention and professional development activities, will be stored by the partners collecting the data. For instance, school interventions carried out in Ireland will generate data collected and stored by TCD. Following each institution’s own data protection policies, in adherence with national and international data protection Acts and regulations, for example, the General Data Protection Regulation (GDPR). The GDPR has been enforced from May 25, 2018, and is a regulation aimed at safeguarding the privacy and personal data of EU citizens, with the requirement for all organizations that process or manage EU citizens’ data to comply with its regulations. The aim is to give individuals more control over their personal data.

In line with this Exten(DT)<sup>2</sup> data will be anonymised, encrypted, or completely deleted after the completion of the project.

The first stage in data processing will be de-identification - the removal of identifying information such as names of people or schools, which will be replaced by a randomly assigned number. Anonymous and de-identified data will be shared with project partners as necessary for data analysis and deposited in the Zenodo repository with suitable metadata for long term preservation and curation.

Data which cannot be de-identified (such as consent forms and video data) will be encrypted and stored on password-protected drives and appropriate measures such as access restrictions, regular backups, and firewalls, will be taken to ensure the security, integrity, and confidentiality of data, based on regulations followed by each respective partner. Personal data will only be accessible to authorized personnel who have undergone relevant training, background checks and agree to maintain confidentiality. In the event of a data breach, the DPO of the institution involved will be informed and will promptly notify all affected parties and take appropriate remedial action. Personal data that needs to be shared for Exten(DT)<sup>2</sup> research purposes will be encrypted before transfer. All data transfers will use institutionally approved data transfer tools which comply with GDPR and provide adequate security such as two-factor authentication. Such data transfers will be kept to a minimum within the

operational needs of the project. Data which cannot be de-identified will not be deposited in the Zenodo repository, but suitable metadata will be used to comply with the FAIR principles.

Throughout the duration of the project the data generated by the ALA platform will be stored in an RDBMS implemented as a fully managed cloud-based service on Amazon VPC (Virtual Private Cloud). This service will be configured to take automatic daily backups as snapshots of the entire database instance once a day in a 30-minute period (backup window). These backups will be stored in an S3 bucket on AWS. Backups will be checked and validated manually in a periodic fashion.

There are three types of users that will be generating data in this project: (i) Educational institutions (i.e., schools), (ii) Designers / tutors, and (iii) Learners. Authentication of accounts for the above entities and authorisation to access system services and generate data will be managed internally by the Exten(DT)<sup>2</sup> platform. The method used for authentication and authorisation is based on JSON Web Tokens (JWT). This system ensures that for every session there will be at least one unique and previously unknown token dynamically generated to allow access. The data stored for each account type follows:

Table 3. Data generated from different account types

Data source	Description
Educational institutions (i.e., schools)	<ul style="list-style-type: none"> <li>Email, password (generated by the platform), name</li> </ul>
Designers / tutors	<ul style="list-style-type: none"> <li>Email, password (generated by the platform), name</li> <li>Learning activities</li> </ul>
Learners	<ul style="list-style-type: none"> <li>Identifier (generated by the platform), real name or alias</li> <li>Interaction indicators with learning tools</li> </ul>

No sensitive data will be stored for any of the account types in the system and no personal data will be stored particularly for learner accounts. (There is a field where the school administrator will have to write an alias for learners.) The student ID and group ID is generated by Exten(DT)<sup>2</sup> platform and the teacher will document which student belong to which ID in his/her own document (paper based or stored on her/his own computer).

According to GDPR regulations (Art. 9 GDPR) there is a clear distinction between personal and sensitive data. Personal data is any piece of information that can be used to identify someone. In that respect the data given above that can be thought of as personal are emails and names. Sensitive data is a special category of data; any piece of data that may reveal a subject’s information can be considered sensitive. Listed below are some examples:

- (a) Racial or Ethnic origin
- (b) Political beliefs
- (c) Religious beliefs
- (d) Genetic or Biometric data
- (e) Mental health or Sexual health
- (f) Sexual orientation

(g) Trade union membership

According to this definition there is no sensitive data stored in the system for any of the participating entities. We can affirm that every access to the information located in the actual database, stored snapshots or archived data will be exclusive to the personnel in charge of the project, following the recommendations of the standard ISO/IEC 27002:2005.



## 8 Ethical Considerations

Discussed below are ethics and legal issues that can have an impact on data sharing. These can also be discussed in the context of the ethics review.

### 8.1 Privacy and Data Sharing and Long-term Preservation

Only anonymous and de-identified data will be made open access. Data generated by the Exten(DT)<sup>2</sup> project which could be used to identify an individual, whether alone or through linked datasets, will not be made available on the Zenodo repository. Original audio, video and screen recordings will be excluded where individuals can be identified, although de-identified transcripts will be included, and suitable metadata created for missing datasets following FAIR principles. All images and recordings of children and young people will be excluded from the open datasets on Zenodo, for the purposes of child protection.

Informed consent to include an individual's data in repositories as part of the open data initiative will be obtained prior to the commencement of all data collection which includes personal data.

However, an established risk of educational research involving teachers in their classrooms is that they might be able to identify themselves or other colleagues. This is explained in the 'risks' section of the informed consent documents and all reasonable measures will be taken to minimize this risk. In addition to ensuring that data has been de-identified, consideration will be made about the metadata (not) used and whether to link datasets or provide contextual information. The focus will be on providing the least amount of data that another researcher might need for the data set to be valuable, balanced with protecting the identity of the individual.

### 8.2 Initial Ethics Board Report and Interaction with the Ethics Advisory Board

Deliverable 9.1, the Initial Ethics Board Report, is also submitted simultaneously as this deliverable in M8. It further considers various ethical issues around data. Particularly noteworthy is Section 5 which reviews ethical questions around data, addresses how identified issues are planned to be dealt with and who will take on (the related) responsibility. It is recommended that D9.1 is read in conjunction with this Initial DMP.

This initial DMP has been reviewed by the Chair of the Ethics Advisory Board (EAB) and feedback provided has been addressed. It will be further shared with the Independent Ethics Expert. The lead author of this deliverable will then join as a guest at forthcoming future EAB meetings to discuss this deliverable and collaborate for future versions. Feedback and recommendations, including those from the Independent Ethics Expert, will be integrated into the next version of the "Updated Data Management Plan" (D1.3) due at M18.

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## Appendix A: Stakeholders and Associated Dissemination Activities

(Source: D8.1 - Exten(DT)<sup>2</sup> Dissemination and Exploitation Plan)

Stakeholder	Dissemination event	KPI	Target	Contingency plan
Academics, researchers	Publication of results in journals, books or special issues	# of publications	6+	Analyze all scientific results for possibility of publication, assign lead authorship and deadline for submission, review process every 6 months.
Academics, researchers	Presentation of results at relevant scientific conferences	# of publications	9+	Periodic review of project activities and advance planning i.e., attendance of at least 1 conference per year per partner.
Academics, researchers, industry organisations	Participation in workshops with existing relevant projects and projects funded under this call	# of workshops	6	Online implementation of workshops to share insights; establish connections right from the start of the project.
Teachers	Project workshops for designing activities and lesson plans	# of workshops	20	Online, live or face to face workshops to enable teacher participations from across Europe; seek teachers and establish connections right from the project start.
Teachers, students	Present the project outcomes in non-scientific educational events: teacher/student conferences	# of presentations	7+	Follow schools and teacher networks online, participate in teacher events, organize open workshops and seminars.

Teachers	Participation at National Scientix networking events fostering collaboration with other and related projects and activities	# of events	3	Contact the National Scientix network and host our own webinars and events for teachers beyond the project to share project results.
Policy representatives	Present the results at policy events/meetings	# of presentations	7	Actively register, attend and present at policy- dedicated events. Host own events with teachers and actively invite policy makers to attend. Publish policy briefings to policy makers.
General public	Participation in open-science events to disseminate the project towards society	# of events	5	Host workshops and seminars open to the public in local or international open-science events such as “Researcher Night” and “EU Hour of code”.
Teachers, students, researchers, policy makers	Make the educational tools available online and easily accessible through the project website	# of yearly users	10K	Partners promote activities further through established national and international teaching and learning networks described above and relevant EU-funded and other projects they have contacts with, as well as through the BBC, and projects funded through this call.
General public	Promote the project through its own and other social media accounts (e.g., university and lab accounts)	# of followers/likes	2K	Partners share content using personal and institutional accounts during and after the project; they schedule timing and content to ensure weekly updates.

General public	Media releases	# of releases	10	Seek support from partner dedicated media teams (e.g., OU and LNU media departments)
Teachers (preservice and inservice)	Release a freely accessible online OpenLearn course (OU)	# of users/viewers	2K	Promotion through press releases and through media teams.
Industry	Dissemination of the project results to industry partners, including private schools and companies	# of presentations	5	Engage with existing conducts at companies such as EnginoEducation <a href="https://enginoeducation.com">https://enginoeducation.com</a> , Hypocampus <a href="https://www.hypocampus.se">https://www.hypocampus.se</a> and Arduino cc <a href="https://www.arduino.cc">https://www.arduino.cc</a> .

## Appendix B: Educational Tools Technical Requirements (MaLT2 Requirements)

(Source: D4.1 - Technical Specification for DT Platform, LA, AR and 3D Printing Technologies)

N	Functional requirements and descriptions
R1.1	Convert the 3D models produced by WebGL to downloadable .obj or .stl files, which are the file types supported by most 3D printers.
R1.2	User interface for downloading the file
R1.3	User interface allowing the user to set some basic parameters for the 3D printing (e.g. texture), facilitating the 3D printing preparation process. The type of parameters will depend on the 3D printer software since they need to be compatible.
R1.4	Capture and export anonymous user interaction data to the Exten(DT) <sup>2</sup> platform that are meaningful and useful for learning analytics.
N	Non functional requirements and descriptions
R1.5	Minimum Build Volume: 250mm x 250mm x 300mm.
R1.6	Support of PLA filaments for safety usage by kids; Preferably support also WOOD and FLEX filaments.
R1.7	Support of eco-friendly/recyclable filaments.
R1.8	User friendly and flexible software.
The exact features & requirements will be finalized after the pilot evaluation of existing technologies with teachers and students and exploration of their needs for technology extension.	
N	Technical Requirements for MaLT2 current version
R1.9	Supported browsers: Internet Explorer (min v.11), Mozilla Firefox: (min v.39), Safari (min v.8), Google Chrome (min v.31) on desktop and browsers like Safari, Android, Chrome, Firefox for mobiles.
R1.10	Hardware requirements: minimum of 2 GB system memory, at least 1 GB of RAM that supports OpenGL 3.0 (Shader Model 4.0).

## Appendix C: Educational Tools Technical Requirements (SorBET Requirements)

(Source: D4.1 - Technical Specification for DT Platform, LA, AR and 3D Printing Technologies)

N	Requirement Description
R2.1	Gesture recognition by any recent computer camera, not requiring any extra Devices
R2.2	Recognition of at least two players at the same time, to support collaborative play
R2.3	Speech recognition by computer microphone, English language. Preferable to support other languages as well.
R2.4	Support programming of game rules by the end-user in a visual programming environment as block-based programming.
R2.5	Capture and export anonymous user interaction data to the Exten(DT) <sup>2</sup> platform that are meaningful and useful for learning analytics.
The exact features & requirements will be finalized after the pilot evaluation of existing technologies with teachers and students and exploration of their needs for technology extension.	
N	Third-party libraries used
R2.6	Blockly.js is a google library that will be used for the block-based programming of the Game.
R2.7	ML media pipe JavaScript library for body and gestures tracking.
R2.8	Speech and voice recognition JavaScript library such as Artyom.js, voice-commands.js or Pocketsphinx.js
N	Technical Requirements for SorBET current version
R2.9	Supported browsers: Chrome, Firefox, Safari 5+, Opera 12+, Internet Explorer 11+ iOS 12+, Safari 12+

## Appendix D: Educational Tools Technical Requirements (ChoiCo Requirements)

(Source: D4.1 - Technical Specification for DT Platform, LA, AR and 3D Printing Technologies)

N	Requirement Description
R3.1	Include interactive map tiles that support different map views, e.g. city, satellite, ground, 360.
R3.2	Use a geolocation API to gather real-time information, e.g. traffic, weather.
R3.3	Enable user as game designer to display an interactive map of their current location along with some information e.g. points of interest, monuments.
R3.4	The exact requirements will be finalized after the pilot evaluation of existing technologies with teachers and students and exploration of their needs for technology extension.
<b>Third-party libraries used</b>	
R3.5	A geolocation API compatible with leaflet. Options: Google maps API (pros: widely used app, has many features that other APIs don't, e.g. routes, places, traffic, supports maps around the world, easy to learn and develop, cons: charges after 28,500 maploads per month), leaflet geolocation plugins (pros: free, cons: not many map types supported, issues or lack of information in some regions, not many data available e.g. routes, traffic)
<b>Technical Requirements for ChoiCo current version</b>	
R3.6	Supported browsers: Chrome, Firefox, Safari 5+, Opera 12+, Internet Explorer 11+, iOS 12+, Safari 12+



## Appendix E: Educational Tools Technical Requirements (ALA Requirements)

(Source: D4.1 -Technical Specification for DT Platform, LA, AR and 3D Printing Technologies)

N	Description	End Users
R4.1	Configuration: the dashboard should allow users to configure it by selecting the most suitable visualization components/widgets for learning activity (or pedagogy approach) and visualization representations for user’s purpose (e.g., tracking student’s individual progress, evaluation, learning activity).	Teachers, Students, Researchers
R4.2	The users should be able to save, load the configured visualization dashboards.	Teachers, Researchers, Students
R4.3	Annotations: the users should be able to make annotations on visualization components/widgets in order to add extra information to complement the visualization.	Teachers, Researchers
R4.4	Annotations: the teachers should be able to make annotations on visualization components/widgets in order to add extra information to complement the visualization and notify this to a particular student or group of students. Students may be able to see the teacher’s annotations to better understand the visualization.	Teachers, Students
R4.5	Notes: the users should be able to make notes in the dashboard for your own use/purpose.	Teachers, Researchers
R4.6	The dashboard for teacher should: (a) provide visualization on different levels: (1) student’s individual level; (2) group level (3-5 students in group); (3) class level (all student in a class 20-25 students), (b) provide visualization which allows to compare the learning activity outcomes between students or groups, (c) provide visualization components/widgets for: (i) student’s learning outcome or performance (ii) student’s individual progress (iii) student’s engagement (iv) student’s developed 21st century skills, (d) provide explanatory visualizations rather/or just exploratory, (e) real-time visualization: during the DT project to monitor groups activities for teachers and highlight groups of	Teachers

	students which needs extra help from teacher; the interface would also emphasize when students are doing well while completing certain tasks, and (f) post DT project activity visualization as summary.	
R4.7	The dashboard for the student should provide: (a) a widget/component for visualizing student's developed 21st century skills, and (b) a widget/component for visualizing student's performance in all phases of the DT process and learning activity.	Students
R4.8	The dashboard for researcher should provide: (a) a widget/component for assessment of DT project or learning activity, and (b) a widget/component for evaluation of DT project or learning activity.	Researchers
R4.9	Visualizations should be more explanatory rather/or then just exploratory.	Teachers, Researchers, Students
R4.10	The visualization should also emphasize when students are progressing well or not well.	Teachers
R4.11	The visualization should support some accessibility features of the dashboard to accommodate disadvantaged (disabled) users or groups.	Students
These requirements and features will be refined and updated after performing several workshops with teachers using participatory design methods.		

## Appendix F: Educational Tools Technical Requirements (nQuire Requirements)

(Source: D4.1 -Technical Specification for DT Platform, LA, AR and 3D Printing Technologies)

N	Descriptions
R5.1	The extension of nQuire for Exten(DT) <sup>2</sup> will include the design of a version of nQuire for use in formal education.
R5.2	It will be a password protected (safe) environment that will be accessible by only students and teachers.
R5.3	It will enable participation by any student no matter their age (currently, nQuire is used by those 16+ years old). This means that students will be able to create their projects and share them with their peers as a way to collect data for their design thinking projects.
R5.4	The teacher will be able to view the pilot studies of students and provide them with feedback before s/he approves their study to be shared with other students/schools of the project.
R5.5	nQuire will enable sharing of outputs from other project technologies such as ChoiCo games for students to share, compare and discuss with others, while it will inform the design of the AI-authorable dashboard by capturing and providing data indicators from nQuire such as students' participation in studies, number of studies created and piloted, number of comments left.