ASSESS MAKE 21

INNOVATIVE DIGITAL SOLUTIONS TO ASSESS 21ST CENTURY SKILLS IN MAKERSPACES

IO4
Evaluation report of pilots

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Erasmus+

Declaration

This report has been prepared in the context of the ASSESSMAKE21 project. Where other published and unpublished source materials have been used, these have been acknowledged.

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'I really love a well-functioning maker-space, I think they're incredibly meaningful places for students to be. Very often — if a parent walks in, or another student walks in, or a colleague or a principal — Makerspaces can look like a chaotic space. Visitors might think 'I can see three kids over there and I'm sure they are just talking to each other'. But I think it's important that people understand — as a reputational thing for makerspaces — and students understand that, just because they are talking to each other or messing with something, that this is also how learning can look. They could be discussing ideas or suggesting trying something else that might work. Learning doesn't just look like sitting in a row doing twenty sums'

-Rosa Devine, Makerspace facilitator, Ireland

1 Executive summary

Makerspaces are found in first of all, non-formal settings, however, they are being implemented in formal education settings as well. There are several reports about how activities in makerspaces contribute to participants' development of different kinds of so-called 21st century skills, such as collaboration, communication, creativity etc. The increased focus on the development of 21st century skills has led to interest in the design of tools that can track and assess the development of 21st century skills. Within the Erasmus+ project, Assessmake21[1], a digital self-assessment tool (also called Assessmake21) has been developed with the purpose of making it possible for users to self-assess their development of five different 21st century skills, collaboration, creativity, problem-solving, social/life and communication, when working with makerspace activities. In this report, we present how the Assessmake21 tool was pilot tested in four countries: Cyprus, Greece, Ireland, and Sweden. The tool was tested in non-formal and formal makerspaces. We developed different data collection tools to evaluate how teachers and students used the tool and how they experienced this use. The data collection tools included pre-and post-questionnaires to students, individual interviews with teachers/educators in makerspaces, focus group interviews with students and also usage data collected from the digital assessment tool itself. We analysed and compared the different data with descriptive statistical analysis as well as thematical analysis of the qualitative data (the interviews). The results showed that there were quite similar results, despite varying contexts in which the Assessmake21 tool was tested.

There were both positive outcomes from the pilots, with various challenges encountered and benefits experienced. The common benefits in all four countries were that the tool made the students aware of the 21st century skills and that they also appreciated the possibility to self-assess their own development of the skills. This was confirmed by the participating teachers and educators. The challenges included some struggles with the language in the tool, especially for younger students. There were also some technical and workflow challenges, for example when uploading images to the tool, or the repetitiveness and time burden experienced by students when completing the reflection tasks. This was frustrating for students who preferred to focus their time and effort on the making activities. Teachers felt that students needed a lot of support in how to use the tool.

Our conclusion is that the tool has benefits, but some adjustments could be made before further use. The concept of the tool and the instructional language around it may need to be simplified and clarified in order to allow students to understand its value. Also, it was clear that students did not consider the tool very 'enjoyable' to use, and in an eco-system of gamified and gratifying interactive tools (i.e., Kahoot), Assessmake21 would need to improve in those domains. Furthermore, the use of the tool did not lend itself to contexts where time was a major constraint, most notably in formal education settings where timetables may allow for only 40-80 minutes of maker time. However, the pilot showed that a tool for measuring 21st century could be successfully used by students in makerspaces, and although there is much room for improvement around the use of the tool, the result of the pilot showed the appetite among students and teachers to use tools that can both increase their awareness of 21st century skills and provide a framework in which they can measure and gather evidence of their use.

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[1] https://www.assessmake21.eu/

2 Introduction

Makerspaces are found in non-formal environments around the world (e.g., Halverson & Sheridan, 2014; Lindstrom, Thompson & Schmidt-Crawford, 2017). However, they have also started to be integrated in formal school settings (e.g., Vourikari, Ferrari & Punie, 2019). Making activities are seen as conducive environments for promoting European Key Competences for Lifelong Learning, e.g., digital competence; competence in science, technology, engineering, and mathematics (STEM); collaboration, critical and analytical thinking; problem-solving; creativity, etcetera. (Vourikari et al., 2019). It is argued that these kinds of skills (sometimes referred to as 21st century skills) are developed during makerspace activities (e.g., Sheridan et al., 2014). How to assess the acquisition of 21st century skills by involvement in makerspace activities is a question being asked and emphasised by educators and policymakers (Vourikari et al., 2019).

However, it is not easy to assess the development of 21st century skills since there is a lack of tools for assessment in this respect. In this project, we focus on how a developed digital self-assessment tool within the project Asessmake21, can be used to identify development of some 21st century skills when students participate in makerspace activities. Within the project, it was decided to focus on self-assessment of the following 21st century skills: *collaboration, creativity, problem-solving, life/social skills, and communication.* The development of the tool is presented in the Assessmake21 IO1 report which can be found at https://www.assessmake21.eu/io1/.

In this evaluation report, we present the outcomes of the pilot tests with students and teachers in the four countries being part of the project: Cyprus, Greece, Ireland and Sweden. Based on the above-mentioned reported interest in trying to assess outcomes of makerspace activities, in terms of development of 21st century skills, and how the Assessmake21 tool can support this kind of development we posed the following questions:

> ➢ How is the tool used by a) students and b) teachers?
> ➢ How is the tool experienced by a) students b) teachers?

Related to these two main questions, were a number of sub-questions:

> ➢ *How well does the tool work – for both teachers & students?*
> ➢ *How is it used in the different contexts/situations?*
> ➢ *Does it meet teachers' needs?*
> ➢ *Is the information it gives to teachers useful? Relevant?*
> ➢ *Does it help students to recognise their use of 21st C skills?*
> ➢ *Does it help answer the question if 21st C Skills are developed during makerspaces activities?*

3 Methodology

In this project we adopted a mixed method approach, meaning that we developed and used different kinds of instruments to collect data. The description of the development process and the final instruments is presented in this section.

3.1 Development of instruments

The process of developing instruments to use for evaluation of the pilots started with a workshop with the consortium partners involved in this project. During this workshop we jointly specified the questions we are supposed to evaluate. The next step was to discuss what kind of instruments we needed and how we could arrange the pilots in our different countries. We realized that the contexts in the countries differ. However, this can be a strength since during the pilot test there was the possibility to observe the use of *Assessmake21* tool in different contexts and compare outcomes. An example output from the collaborative workshop held between Learnovate, CIL, Edumotiva and Karlstad [Karlstad University] is shown in Figure 1. (A larger version of this image is shown in Appendix III, Section 10)

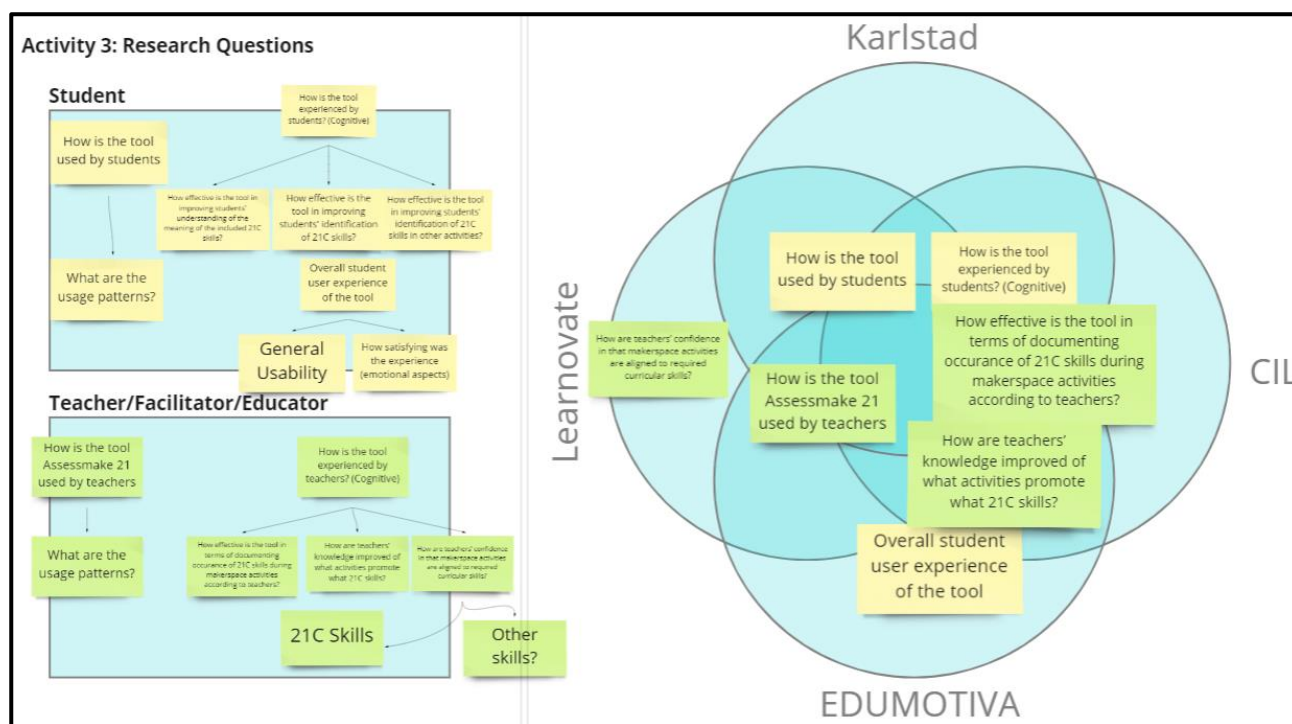*Figure 1: Workshop to develop research questions and related instruments*

From the workshop, a number of items were identified that required evaluation. This included aspects of student and teacher user experience, tool effectiveness, and impact on teacher and student development. These items are presented in Figure 2 in conjunction with the suggested instruments that could capture this data.
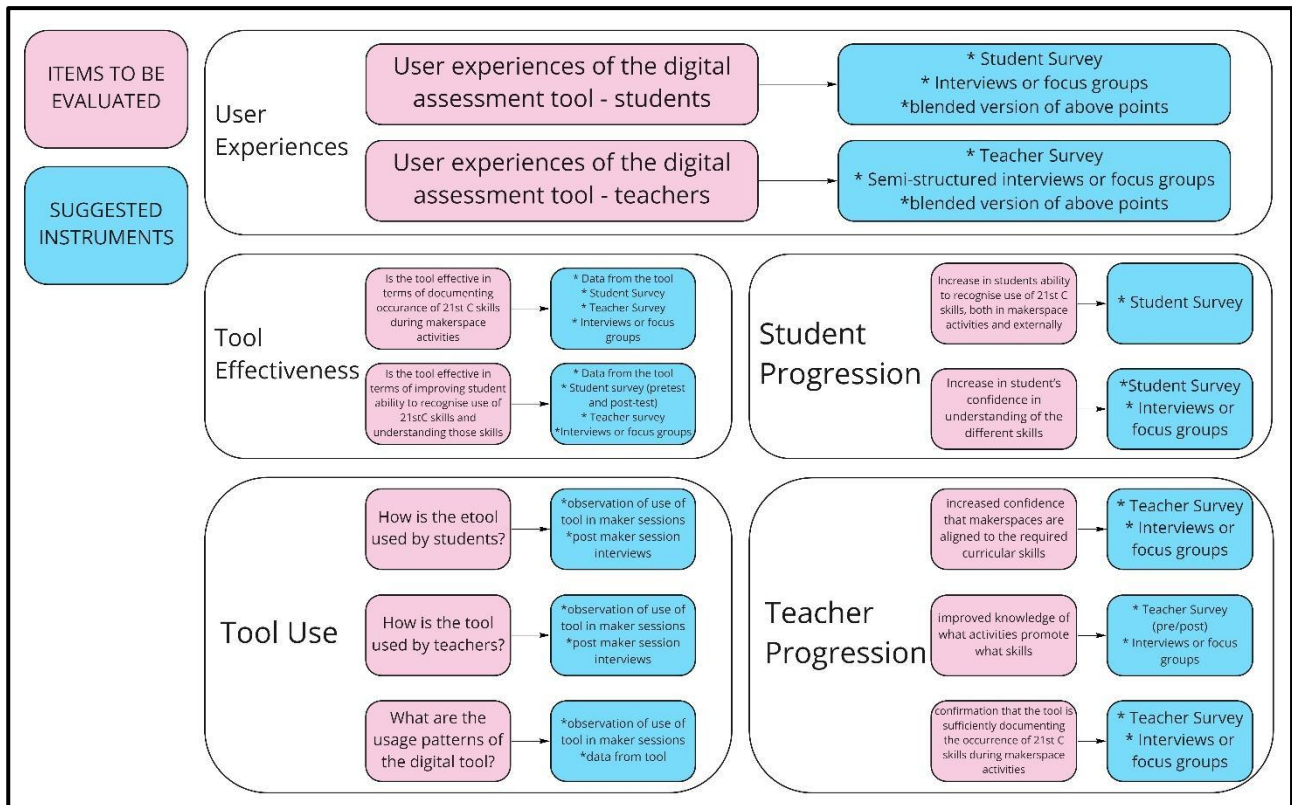
Figure 2: Recommended instruments to answer research questions

The process of developing the instruments continued in an iterative manner, with feedback from partners incorporated into the development. Questions were revised based on comments and feedback from all partners. This process was done via online sharing of documents and discussions in project meetings.

3.2 Description of the instruments

The development process of instruments to use for evaluation of the pilots ended up with agreement to use the following instruments:

  ➢ Data to be collected from the Assessmake21 tool (usage data, image uploads, text entries),
  ➢ Pre-questionnaire to students (Likert style),
  ➢ Interview guide for focus group interviews with students after activities,
  ➢ Interview guide for interviews with teachers,
  ➢ Post-questionnaire to students (Likert style).

Details of each of the instruments, including the items and questions contained within, are presented in Appendix I (Section 8).

3.3 Data analysis

  ➢ **Usage data from the Assessmake21 tool** was collected and analysed. Data included:
    o Number of active users

- o Number of Session
- o Number of Tags
- o Number of Tags per Skill
- o Number of artefacts uploaded
- ➢ **Data from the questionnaires** were analysed using descriptive statistical analysis.
- ➢ **Data from the interviews** with both students and teachers were transcribed and themed. Data from each country was treated individually in order to understand the experience of each country, then themes from each country were compared to find common themes among countries

3.4 Ethical approvals

Each partner has their own procedures of how the ethical approval processes work, since there are different regulations in the different national contexts and organisations. All partners sought direct consent from schools, teachers, parents, and students. An example recruitment and consent flow utilised in Ireland is shown in Figure 3.
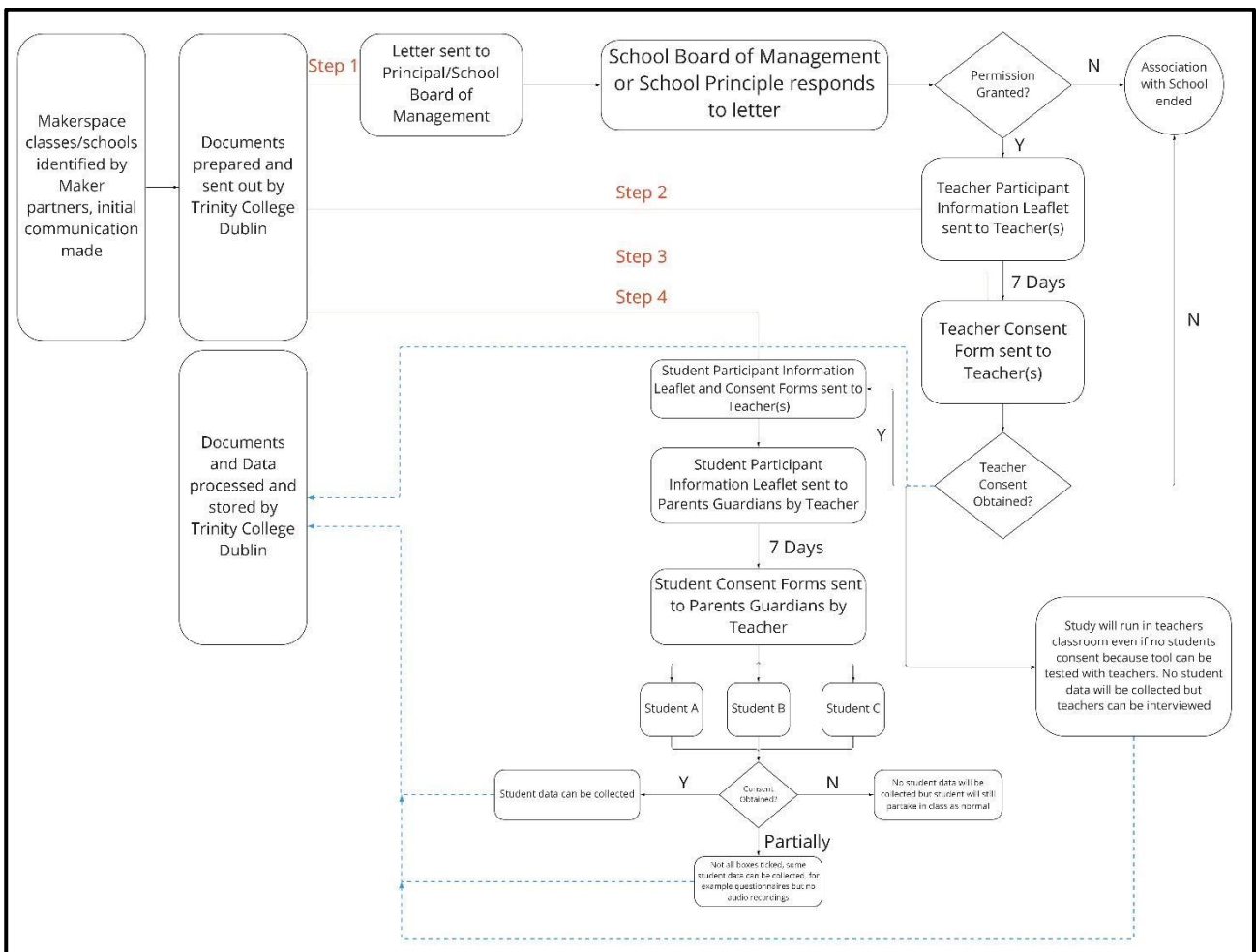

Figure 3: Recruitment and Consent flow in Ireland, while this was the not the exact process followed in all countries it illustrates the steps that were taken across the project to ensure high ethical standards that were maintained throughout the project for data handling and consent

3.5 Description of national contexts

In the section below there are descriptions of each of the national partners contexts where the pilots were conducted. Table 1 presents an overview and thereafter additional descriptions are presented of each national context.

Table 1: Overview national Contexts. *Approach is possible to choose as Parallel (1st) meaning that challenges and tagging (input) are made during the Makerspace Activities. In the Second approach (2nd), tagging (input) is made during makerspace activities when the students feel that they are using 21 century skills. At the end of the activities, they can take a series of challenges based on what skills they have been tagging the entire time. Finally, using the end approach (3rd), the students are able to use a scale bar to rate the 21 century skills they believe to have used (and to what extend) after completing their makerspace activities. Following that, they will take a series of challenges based on their tagging input. **Duration is possible to choose as short, medium, or long. The short mode includes 4 challenges and 1 picture taken. The medium mode includes 6 challenges and 2 pictures taken. The long mode includes 8 challenges and 4 pictures taken.

Pilot Characteristic	Cyprus (CIL)	Ireland (Learnovate)	Greece (Edumotiva)	Sweden (KAU)
Number of school classes/groups	6	3	3	6
Number of students	105	Group1:21 Group2: 38 Group3: 24	Group1: 12 Group2: 12 Group3: 8	114
Age of students (years)	12-18	12-16	13-17	13-15
Number of teachers	6 (4 from formal education and 2 from non-formal educational settings	3	2	4
Makerspace context (formal/non-formal)	Formal education and non-formal education (extra-curricular activities classes)	Formal in schooltime	Formal education (one class) Non-formal maker space (two groups)	Activities in formal education. Collaboration with non-formal makerspace
Maker activities	**G1:** 3D printer, LEGO EV3	**G1:** 3D printing projects, Chemistry,	Non-formal: Paper circuit making, 3D	Programming in scratch

| | Mindstorms, Arduino

G2: LEGO WeDo, Spike

G3: 3D printer, LEGO EV3 Mindstorms

G4: 3D printer, Remote-controlled Drone Creation

G5: 3D Pen

G6: Micro: bit, Arts and Crafts, Edisson | Maths, Coding, TinkerCad

G2: Microclips, gator clips, laser cutter, 3D printer, robotics, electronic manufacture, design and build space stations

G3: 3D printing projects | modelling and printing

Formal: sketching, 3D designing, prototyping, electronics in the context of 4 maker projects | Programming with Micro:bits

Design process projects

Programming in Roblox |
|---|---|---|---|---|
| Length of maker projects | **G1:** 2 hours per week

G2: 80 minutes per week

G3: 1 hour per week

G4: 1 hour per week

G5: 80 minutes per week

G6: 80 minutes per week | **G1:** 40 minutes per week

G2: 1-2 hours per week

G3: 1-2 hours per week

6–8-week period for both groups | **Non-formal:** approx. 3 hours per week, Jan 2022 - early May 2022

Formal: 1 hour per week (Jan 2022- mid May 2022) | 4-13 lessons

Each lesson 80 minutes, plus one full day project. |
| Approach* used in Assessmake21 tool | **G1:** At the end approach (3rd)

G2: Parallel approach (1st)

G3: Parallel approach (1st)

G4: At the end approach (3rd) | **G1:** 2nd approach

G2: 1st approach

G3: 3rd approach | **Group 1 & 2:** 1st and 2nd approach

Group 3: 3rd approach. Teachers pre-tested the approaches to see what better facilitates their needs based on | At the end approach, one teacher tested all three approaches, one/class. |

	G5: At the end approach (3rd) **G6:** Parallel approach (1st)		the complexity of each project.	
Duration** used in Assessmake21 tool	Short	Medium	Short & Medium	Short
Students' devices	**G1:** Laptop - upload photo from mobile phones **G2 - G6:** Tablets	**G1:** Desktop computers, upload photo from mobile phones **G2:** iPad **G3:** iPad	**Formal:** PC **Non-formal:** PC, tablets, mobile phones	PC or Chromebook

3.5.1 The Cyprus context

Six groups of students (n=79) from three urban and two rural schools of Cyprus participated in pilot sessions to explore the use of the Assessmake21 tool. 47% were boys, and 53% were girls. 85,5% belonged to the age group 10-12, 6,5% to the age group 13-15, and 8% belonged to the age group 16-18. There were three male and three female teachers (n=6). Four of them had approximately 20 years of experience in making, while the other two had extensive teaching experience in education but they reported no experience in making. Two of them were elementary school ICT teachers. The other two were teaching in secondary education.

3.5.1.1   Participants

Six groups of students participated in the pilots, signed formal consents and completed pre-test questionnaires. There were three urban schools, located in Famagusta and Nicosia, and three rural schools / after-curriculum classes located in the Famagusta district. Table 2 shows the characteristics of the groups and educators in the Cypriot context.

Table 2: Groups in Cyprus

Group	Location	Group Characteristics	Educator / Facilitator
1	Lyceum Archbishop Makarios III -	15 students (aged 16-18, boys and girls). Working collaboratively in groups of 4-5 on robotics and programming projects during breaks and free school hours. Students come from Computer or Design	Programming teacher interested in learning more about makerspaces.

		& Technology classes and are particularly interested in these topics.	
	Dasoupoli, Nicosia		
2	Avgorou Primary School B, Avgorou, Famagusta	20 students aged 12 years old, boys and girls working collaboratively on group robotics projects during their Design & Technology classes	The school's principal and teacher from Design & Technology classes with an interest in makerspaces.
3	Apoplous Cultural Lab,Frenaros, Famagusta	16 students aged 12 years old, boys and girls working collaboratively on group projects during their extra-curricular activities.	Educational robotics expert, interested in learning more about makerspaces.
4	Apoplous Cultural Lab,Frenaros, Famagusta	3 male students, aged 12 years old working individually on building their drones, during extra-curricular activities	The facilitator is a drone expert, interested in learning more about makerspaces.
5	Tseriou Primary School B, Tseri, Nicosia	20 students aged 12 years old, boys and girls working individually on their projects during their Design & Technology classes.	Teacher who teaches all Design & Technology classes in the school, interested in learning more about makerspaces.
6	AyiaNapa Primary School, Antonis Tsokkou,Ayia Napa, Famagusta	20 students aged 12 years old, boys and girls working collaboratively in groups of 3 during the Design & Technology classes.	Teacher who teaches all Design & Technology classes in the school, is also the ICT teacher of the school and a PhD student with a research interest in makerspaces.

The location of the groups in relation to the map of Cyprus is shown in Figure 4.
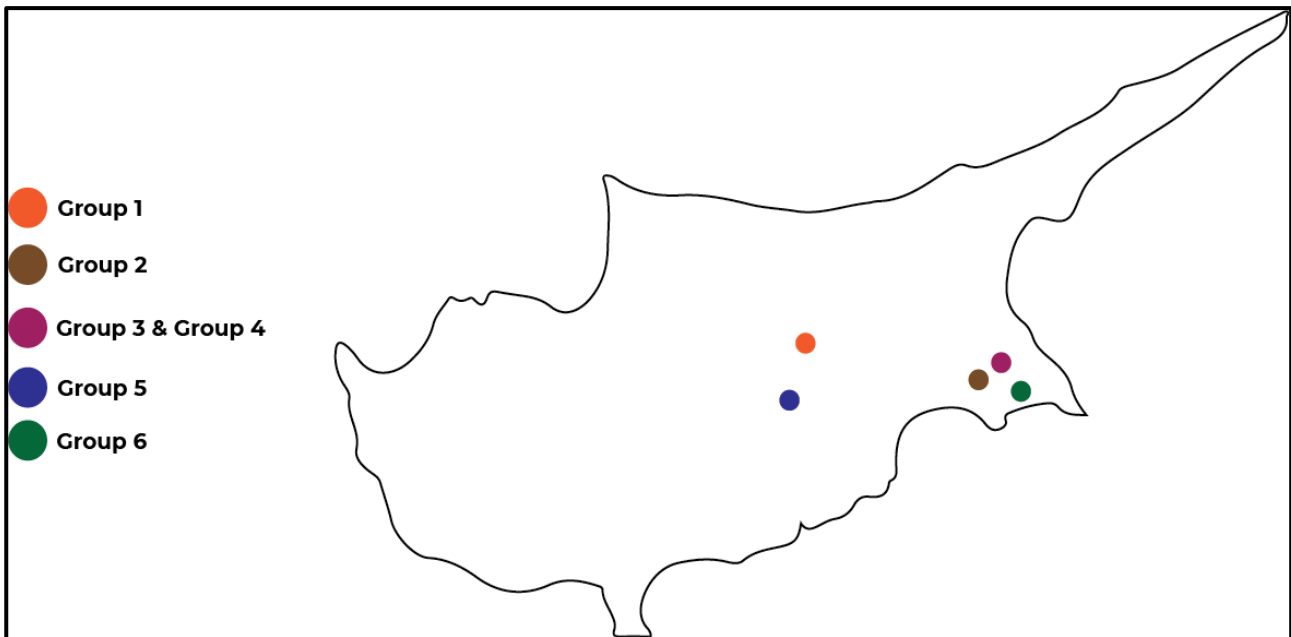
Figure 4: Locations of The Cyprus Context

3.5.1.2 *Makerspace Activities*

In Group 1 students worked on projects related to Programming, Circuitry, Robotics, and Digital Fabrication. They primarily used LEGO EV3 Mindstorm and Arduino circuits for the smart city projects and 3D printers for digital fabrication. Students used laptops for the Assessmake21 tool and their personal smartphones to take pictures and later upload them to the laptops. This group of students used the short duration and the End Approach (3rd) for the use of the tool, 2 hours per week.

In Group 2 students worked on projects related to Programming and Robotics. They primarily used LEGO WeDO and Spike. Students used their individual tablets for the Assessmake21 tool. This group of students used the short duration and the Parallel Approach (1st) for the use of the tool, 80 minutes per week. Students enter national robotics competitions, such as Robotex.

In Group 3 students worked on projects related to Robotics and Programming for participating in the Robotex Competition and WRO Competition. They primarily used Lego EV3 and 3D printers. Students used their individual tablets for the Assessmake21 tool. This group of students used the short duration and the Parallel Approach (1st) for the use of the tool, 1 hour per week.

In Group 4 students worked on projects related to Microcontrollers and Digital Fabrication. They primarily used microcontrollers and 3D printers for creating remote-controlled drones. Students used their individual tablets for the Assessmake21 tool. This group of students used the short duration and the End Approach (3rd), for the use of the tool, 1 hour per week.

In Group 5 students worked on their projects related to digital fabrication using 3D pens. Students used their individual tablets for the Assessmake21 tool. This group of students used the short duration and the End Approach (3rd) for the use of the tool, 80 minutes per week.

In Group 6 students worked on their projects related to programming, robotics, arts and crafts, and digital fabrication. They primarily used Micro:bit controllers, crafting materials and Edisson robots. Students used

their individual tablets for the Assessmake21 tool. This group of students used the short duration and the Parallel Approach (1st) for the use of the tool, 80 minutes per week.
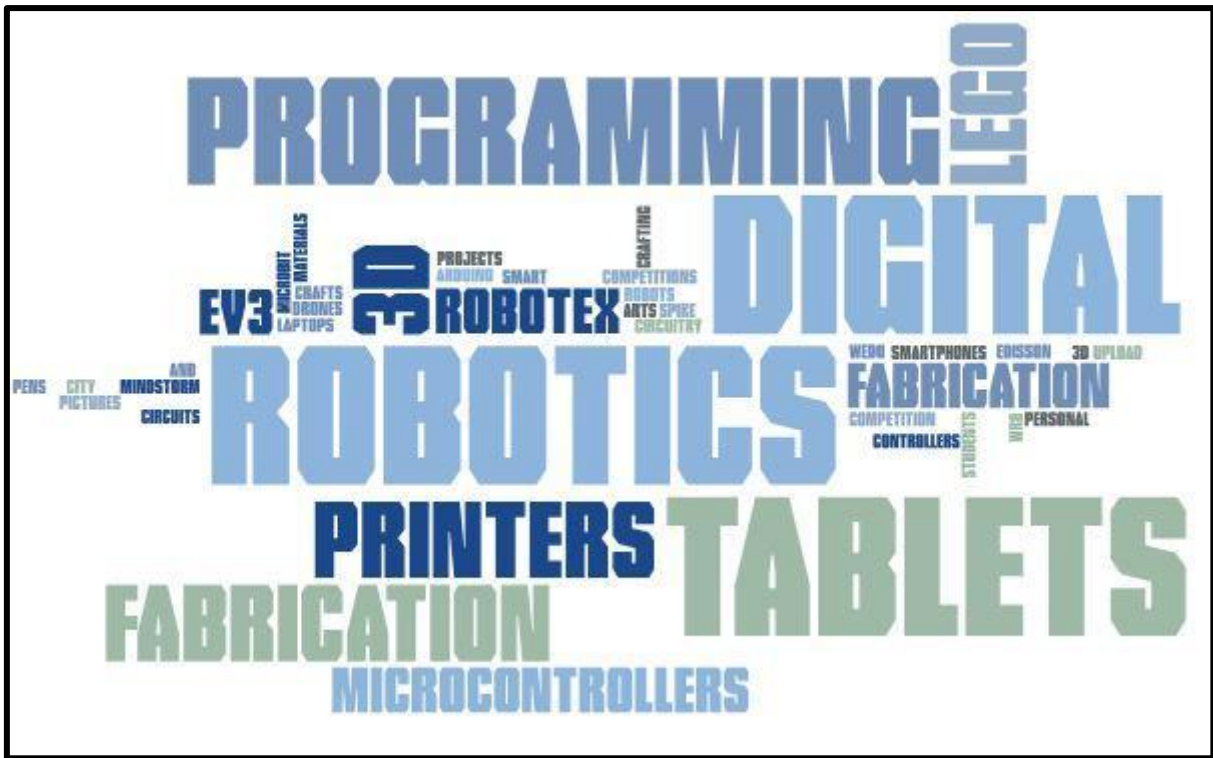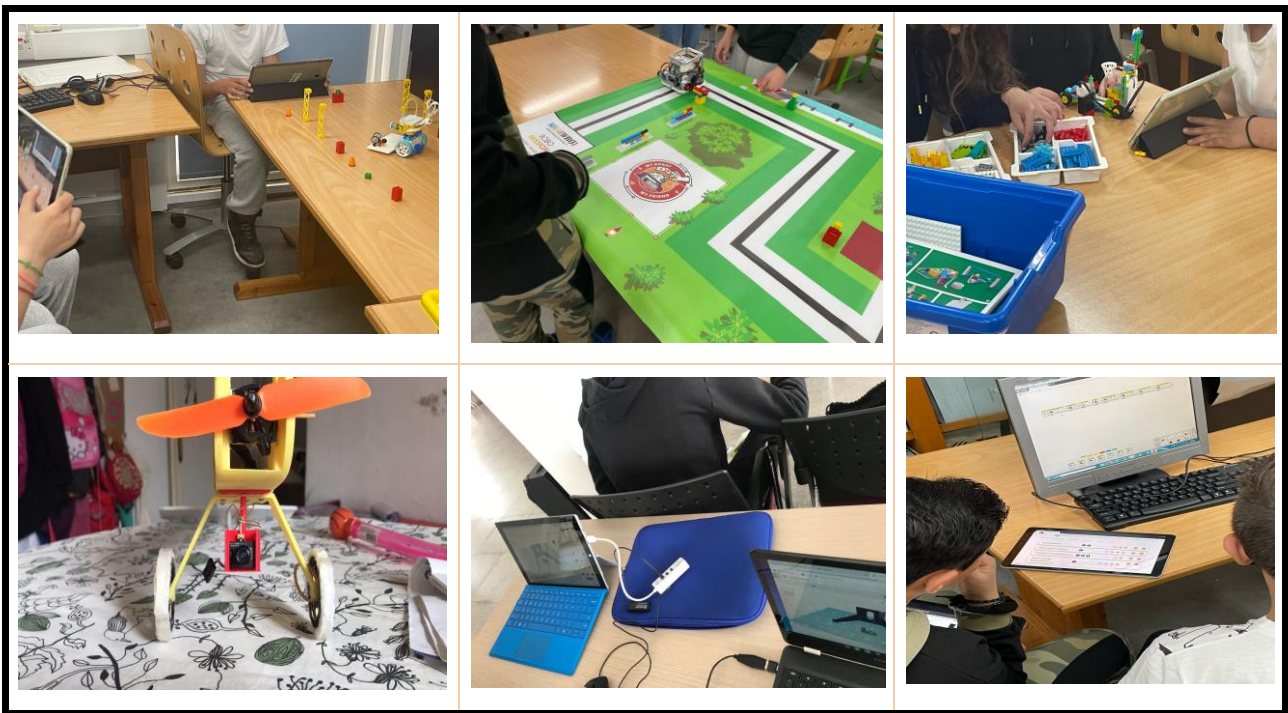

Figure 5: Word Cloud showing key words in Cypriot Context

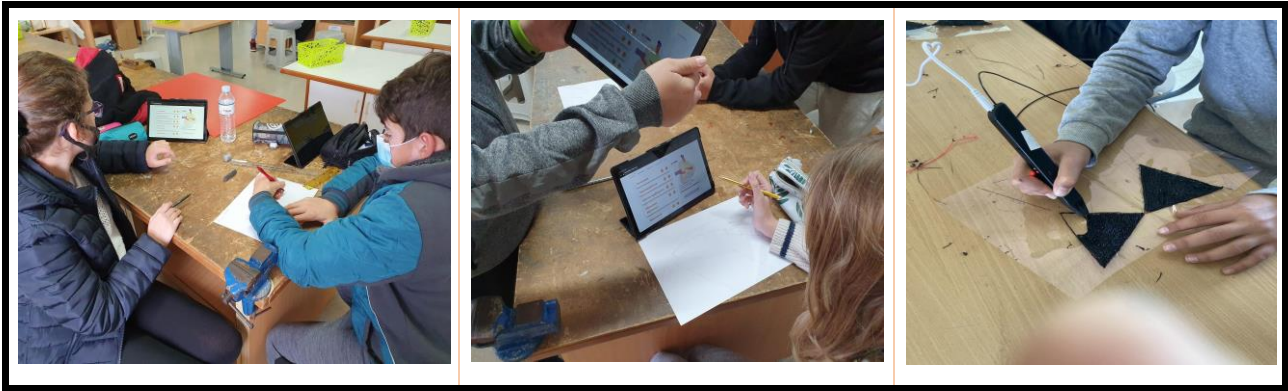Figure 6 shows students conducting activities within the makerspaces.

Figure 6: Examples of students working with: Lego WeDO 2.0 & LEGO Education Spike, LEGO EV3 robots on a challenge, called "Follow the line" for Robotex, fabricating remote controlled drones, using 3D-pens to learn geometry and sketches for final artefacts.

3.5.2 The Greece context

3.5.2.1 Participants

In Greece, two groups participated in the pilot. The details of the two groups are presented in Table 3.

Table 3: Groups in Greece

Group	Location	Group Characteristics	Educator / Facilitator
1 **Non formal pilot site**	23rd Gymnasium of Athens	The makerspace operated after school hours with students 13-15 years old. 24 students expressed interest in participating in the pilots with 17 eventually taking part (spilt into two classes). Students worked in groups of 3-4.	1 educator (male) supported the makerspace activities.
2 **Formal pilot site**	FabLab of the Pierce, American College of Greece in Athens	One group of 8 students (13-17 years old). The students worked in groups of four (4), the youngest members, shaped one group and the older members the other group.	1 teacher (female)

As far as the **data collection process** is concerned, this was completed with the participation of:

➢ 25 students (17 from the non-formal and 8 from the formal pilot site) who filled in the pre and post questionnaires
➢ 18 students that took part in the focus-group interviews and
➢ 2 teachers (1 from each pilot site) who provided their feedback through interviews

The location of these groups in Greece is shown in Figure 7.
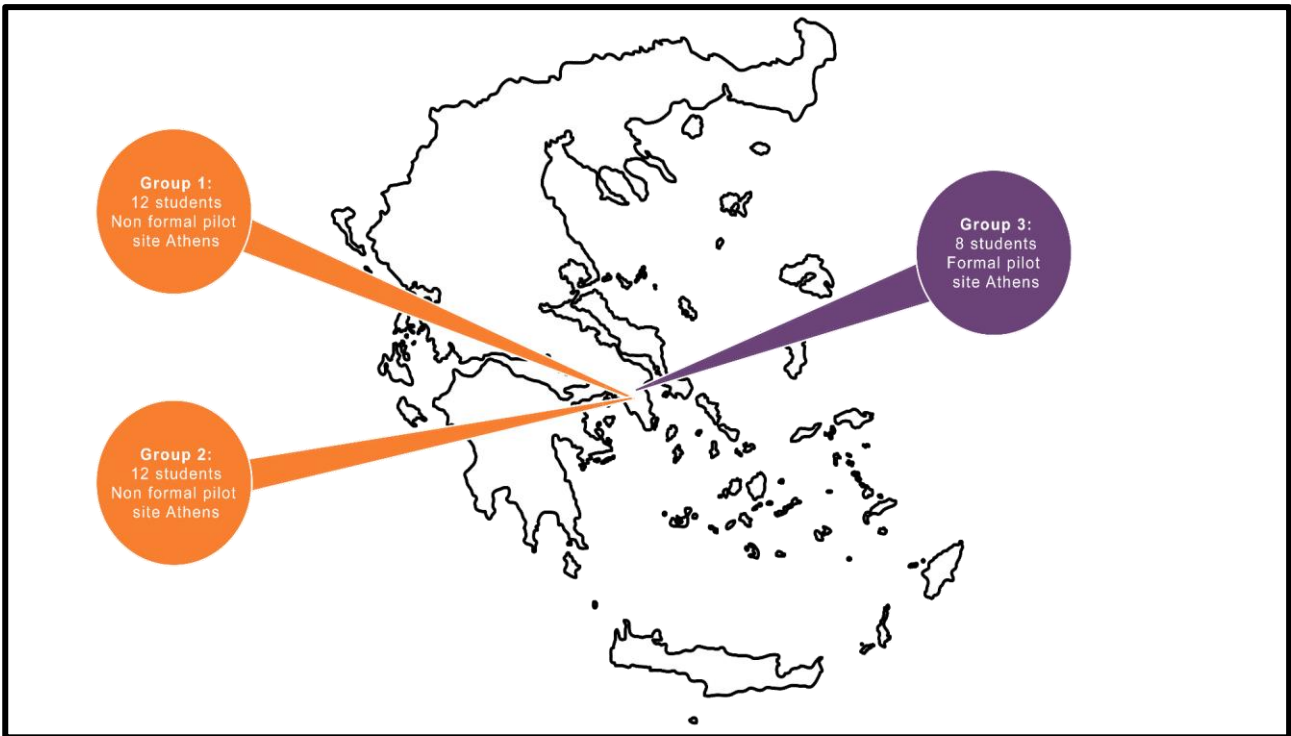
Figure 7: Locations of The Greece Context

3.5.2.2   *Group 1 (Non-formal) Makerspace Activities*

The makerspace took place within a former Computer lab of the school which in 2020 has been upgraded with tools and resources to facilitate the making process. The room had:

➢ 13 working stations

➢ 5 Tablets

➢ A making corner with materials for crafting (copper tape, scissors, thick paper, paper clips, markers, tape and more)

➢ A 3D printer

➢ A smart interactive Board

➢ Robotic technologies

➢ Electronic components

➢ Tables & chairs (that could be freely move around to facilitate different learning schemes)

To further support the makerspace activities and provide flexibility where necessary, EDUMOTIVA offered a mobile makerspace suite for optional use during the Assessmake21 pilots. The mobile makerspace (designed in the context of the STEAM2GO Erasmus+ project) was equipped with crafting materials and tools, electronic components and sensors, microcontrollers, 3D pens and two tablets.
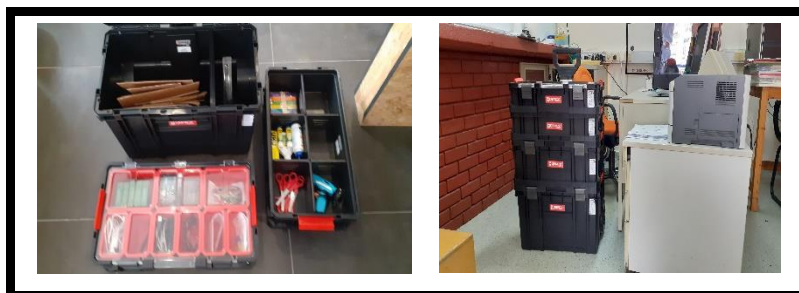
The pilot with this group lasted during five months (Jan 2022 - May 2022). The young makers and the educator (s) met each other once a week for 2.5-3 hours. Before using the tool, a familiarization/ preparatory stage was conducted by the educator across two sessions. This was considered important for the smooth introduction to the tool. This stage was used to ensure that all the participating students had a certain understanding of the process to be followed, and to demonstrate the use of the tool.

To increase understanding of the purpose of the tool, the educator also created leaflets where each of the five skills were explained in an easy to grasp way. Foreseeing the need for streamlining of the login process to the Assessmake21 tool, the educator distributed credential cards to the student.

A   **B**

Figure 8: A) The Assessmake21 "identity" cards, B) Leaflet with the descriptions of the 5 skills used by a group of students

According to the educator:

> *"It was important to spend time on preparation. I would like to ensure that the students have understood the skills upon which they are going to reflect. These are new concepts for the students. So, we started with a familiarization stage with the tool, we also used the definitions available in the tool to discuss the skills. For example, what do we mean by creativity and how can we recognise that in practice? In addition, I decided to prepare a leaflet with definitions for each skill, with brief and easy to grasp references. The students could consult this leaflet anytime if needed. This, I think, proved to be very useful".*
>
> *-Educator A, Greek non-formal pilot site*

The students in each class carried out two maker projects that provided them with the opportunity to engage in handcrafting, electrical circuit making, wiring, 3D modelling and printing.

The **first project** revolved around the creation of paper circuits which is effectively a paper model enhanced with an electrical circuit. The low-voltage circuit is created on paper or cardboard using conductive copper tape, LEDs and a power source such as a coin-cell battery. The 1st approach with short duration was used during this project.

The final artefact took the form of greeting cards, interactive paintings, simple paper pages (inspired by stories) enhanced with lights and more. The students were involved in painting, crafting, collaging, electrical circuit making, 3D paper constructions and creative use or re-use different materials. Examples of artefacts created by students are shown in Figure 9.
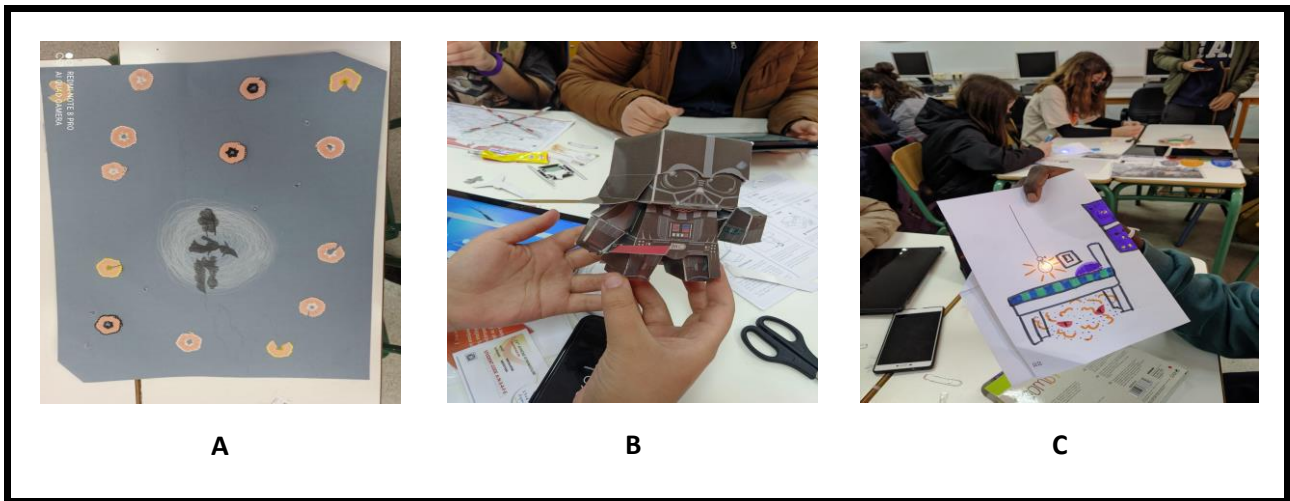

A **B** **C**

Figure 9: A) "The Witcher", a fairy-tale inspired and paper-circuit- enhanced artefact B) Star Wars 3D-paper avatar enhanced with an electronic circuit. C) "My bedroom" painting enhanced with an electronic circuit.

The **second project** revolved around the creation of everyday objects using 3D modelling and printing techniques. The students decided to create a keychain and personalize it by adding their names, the name of the school or their team or symbols that were meaningful to them. The project started with a planning phase where they made more concrete plans on what they would like to design. The teacher facilitated the learning process and students' engagement in the 3D modelling environment of Tinker CAD. When the 3D modelling phase was over, the 3D printing phase started which involved trial and errors, failures and excitement when the print-outs were successful. To better facilitate the needs of the second project, the educator decided to activate the 2nd approach with a short duration.
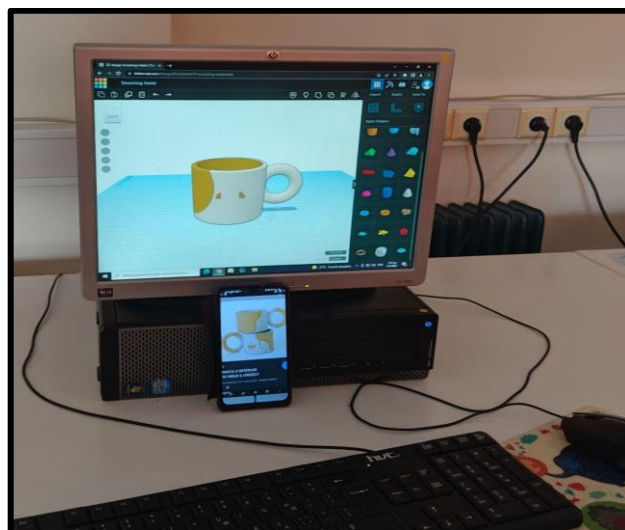

Figure 10: The 3D-model of a cup in TinkerCAD

3.5.2.3 Group 2 (Formal) Makerspace Activities

The Assessmake21 tool was also piloted in the Pierce, American College in Athens. Since November 2019, Pierce College has a Fab Lab for use by its students. The space is equipped with:

- ➢ 3D printers
- ➢ a laser cutter
- ➢ a 3D scanner
- ➢ a vinyl cutter

- ➢ a CNC Machine
- ➢ robotics kits and
- ➢ an electronics workbench for experimenting with creative electronics, such as sensors, microcontrollers, conductive ink, e-textiles, etc.

The activities that take place in the Fab Lab, are based on an experiential, interdisciplinary approach, in which theory becomes practice, with the aim of cultivating 21st century skills, such as combinational and analytical thinking, collaboration, empathy, complex problem solving, etc. Pierce has a number of established Clubs (i.e., Chemistry Club, Biology Club, ICT Club) to which students can register. In line with the formal school curriculum objectives the students are encouraged to work together and go through different stages towards artefact construction, such as research, brainstorming, sketching, 3D-designing, prototyping, experimenting with electronics (to enhance the artefact). Four projects were carried out during the Assessmake21 pilot implementation period that provided students with the opportunity to engage in digital fabrication, 3D modelling and printing and electrical circuit making. The pilots with this group lasted five months, from January 2022 until mid-May 2022. The young makers and the educator met once a week for one hour.

The **first project** revolved around the design of everyday objects that can be used in the FabLab of the College. The students went through different stages (i.e., research, planning, sketching) towards deciding upon the objects to be designed before being actually involved in the 3D-modelling and printing process. Among the objects that were designed were: pen holders, stands for pencils and 3D-pens and other desk/office utilities (Figure 11).
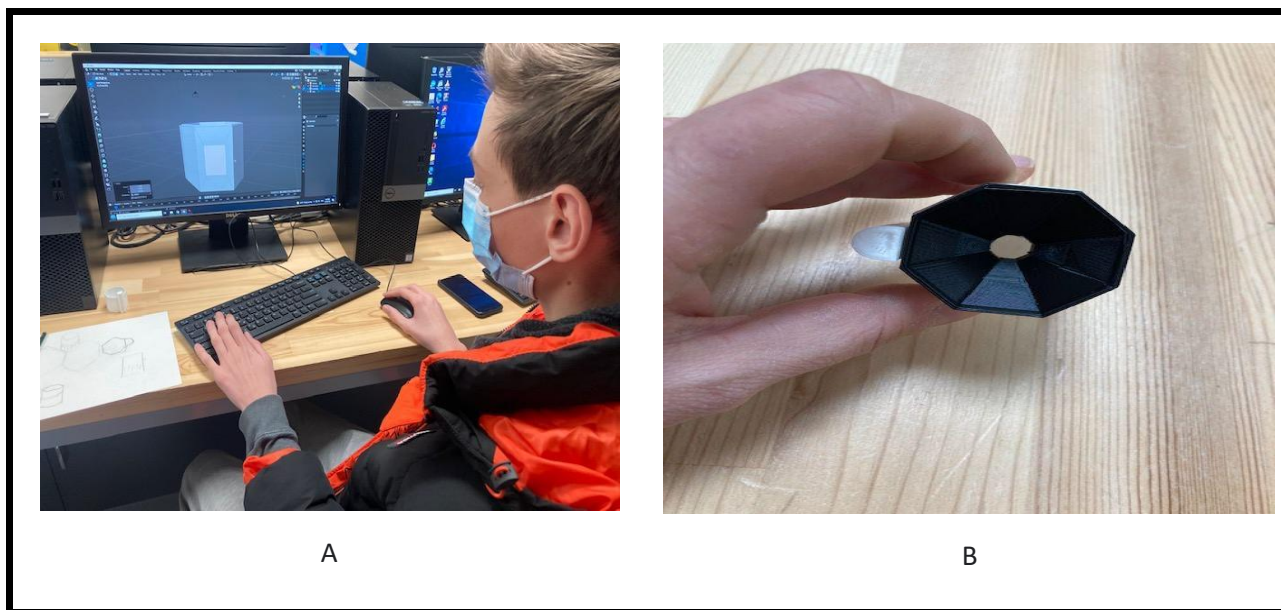
Figure 11: a) Sketching and 3D-modelling b) single stand for pencils.

The **second project** also drew upon actual school needs coming this time from the Chemistry Club of the College. The students of the Chemistry Club were working on the creation of the periodic table. The students that took part in the Assessmake21 pilot activities supported their classmates by designing a) everyday objects that could be directly connected with some chemical elements (i.e., the design of a Helium balloon to accompany the Helium chemical element) and/or b) specific chemical compositions (i.e., the compound caffeine. Once again, the students went through different stages (research, sketching, 3D-modelling and 3D-printing) towards delivering something useful to the Chemistry Club. Below you can see an interview episode with the students that provides some insight into the way they worked on this project:

Interviewer: [...] Resin. What did you make with resin?

Student 1: A balloon. This is going to be placed in the periodic table which is in the hall of our school. We used a 3D-printer to make it.

Student 2: It represents the Helium.

Student 1: Yes of course the Helium, it is a helium balloon… in general we experimented with different materials and equipment [...]. We also did some sort of research.

Interviewer: It sounds like an opportunity to learn some new things about Chemistry?

Student 2: This specific project was related to Chemistry, yes! Not all the projects are…

Student 1: …they told us [he is referred to the Chemistry Club members] that they need objects related to each chemical element. This way, someone who views the periodic table can more easily understand practical issues around chemical elements. We supported this task through designing.

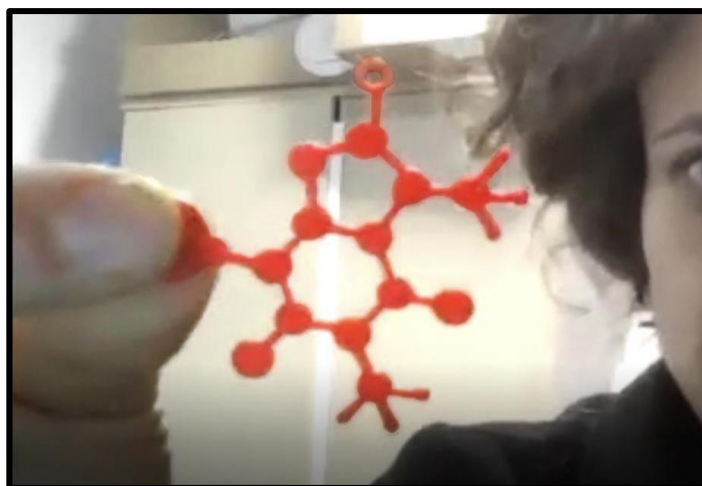*Interview episode with students (Greek formal pilot site)*

Figure 12: A 3D-printed version of caffeine, which was also launched as a jewel.

The third project was carried out in the context of a competition about sustainable and environmentally friendly solutions for cities. The students (after teacher's prompt) were separated into two groups and worked on their ideas: 1) design of an automatic plant watering system and 2) application of a smart lighting system when it gets dark in the parks.

Apart from being engaged in research, planning, 3D-modelling, printing and prototyping, the students were also involved in circuitry, use of sensors and solar panels and programming. Some key steps that the students went through towards finalizing the third maker activity are shown in Figure 13.

A   B   C
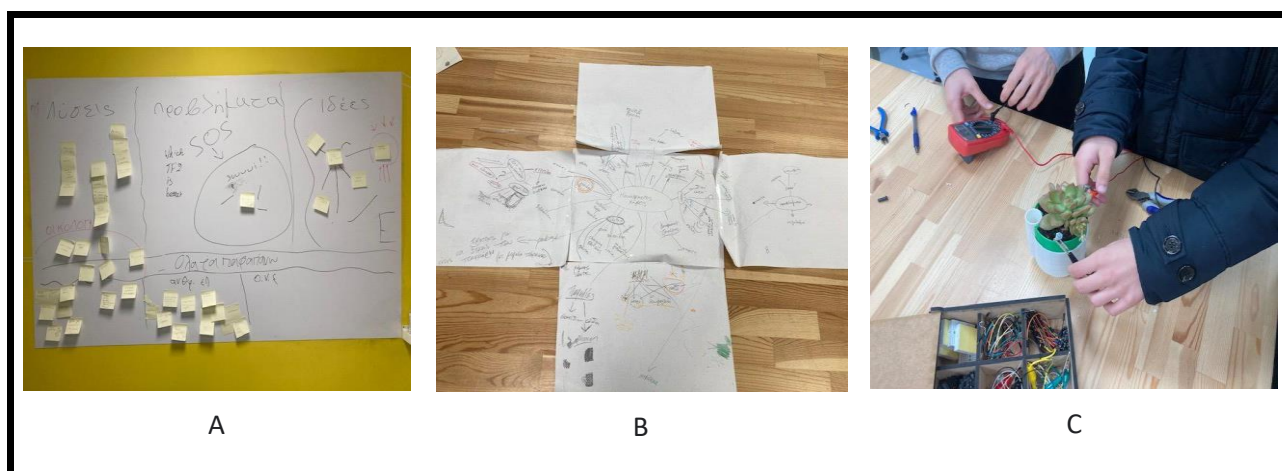
Figure 13: a) brainstorming and idea organization b) planning a solution c) Towards an automatic plant watering system.

The fourth project was again a response to school needs. The task for the students was to design trophies for the school finalists. It was an opportunity for students to express their creativity, replenish their imagination and design something aesthetic and useful using the available equipment in the FabLab. A wordcloud representing the various activities in Greece is shown in Figure 14.
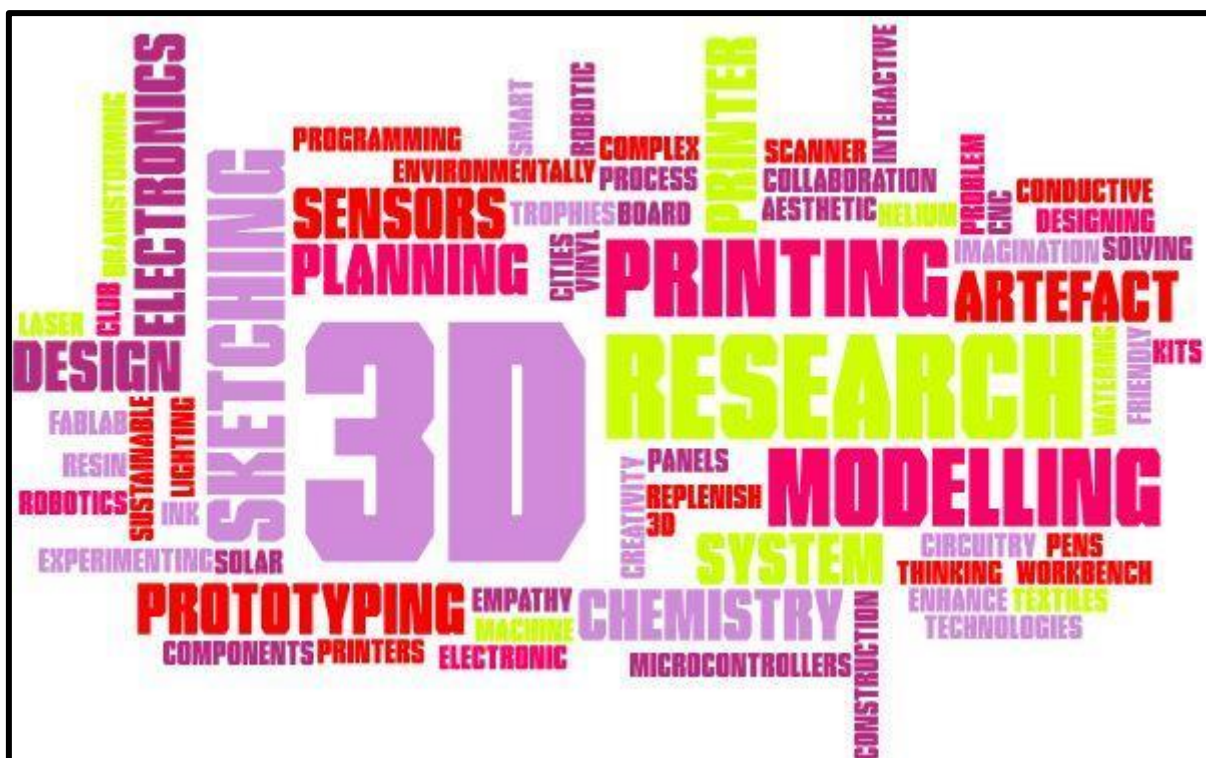
Figure 14: Wordcloud of Greek activities

3.5.3 The Ireland context

3.5.3.1 Participants

Two groups of students were formally involved in the trial (signing consents and filling out pre-trial questionnaires) while another group have also used the tool in maker sessions. From this third group we were able to capture some usage data. The characteristics of the groups are presented in Table 4.

Table 4: Groups in Ireland

Group	Location	Group Characteristics	Educator
1	Loreto College Mullingar in the Irish midlands	20 students in transition year (15-16 years old, all female). Students worked in seven groups of three on 3D printing-based projects, entering competitions throughout the year on different design themes.	STEM teacher, hoped to use Assessmake21 as a type of self-reflection diary to document the students' experience with their maker activities and allow them to reflect on their 21C skills.
2	Belmayne Educate Together School in Dublin	38 students in 1st and 2nd year (12-14 years old, boys and girls), working in groups of various sizes on different maker projects as part of a set curriculum, 1h a week for 1st years,	STEM teacher, much like group 1 facilitator hoped to use Assessmake21 as a kind of workbook

		2h per week for 2nd years. Each student had an iPad to use the tool.	
3	St Clare's Comprehensive School in Leitrim (quite rural)	24 transition year students aged 15-16, boys and girls. Their makerspace orientated around the use of 3D printers for various projects.	Teacher interested in teaching students about 21C skills and liked the idea of having a tool to track the use of the skills.

The location of the three groups with respect to Ireland is shown in Figure 15.

Figure 15: Locations of The Ireland Context

3.5.3.2 *Makerspace activities*

In group 1, the maker activities included projects related to Chemistry, Maths, Coding, 3D Printing, use of TinkerCad. Students used desktop computers keeping the Assessmake21 window open, but uploaded photos to the platform by taking photos on their phone and uploading to the desktop via Google Classroom. They used the tool for about 40 minutes a week, using the 2nd approach, medium duration.

In group 2, makerspace technology included microclips, gator clips, laser cutter, 3D printer, robotics. maker blocks, sets of small random projects. Electronic manufacture. Space week, theme on the ISS. Design and build space stations. The format of sessions was to first research and brainstorm, coming up with ideas, and working in teams. Classes were themed on the use of 21st century skills. One of the facilitators in Ireland summed up her feelings about the kinds of Makerspaces run in her school.

> *'I really love a well-functioning maker-space, I think they're incredibly meaningful places for students to be. Very often if a parent walks in, or another student walks in, or a colleague or a principal, Makerspaces can look like a chaotic space, they might think 'I can see three kids over there and I'm sure they are just talking to each other'. But, I think it's important that people understand as a reputational thing for makerspaces, and that students understand, that just because they are talking to each other or messing with something, that this is also how learning can look. They could be discussing ideas or suggesting trying something else that might work. Learning doesn't just look like sitting in a row doing 20 sums'*
>
> *-Makerspace facilitator, Ireland*

Pictures from the Maker contexts are shown below:

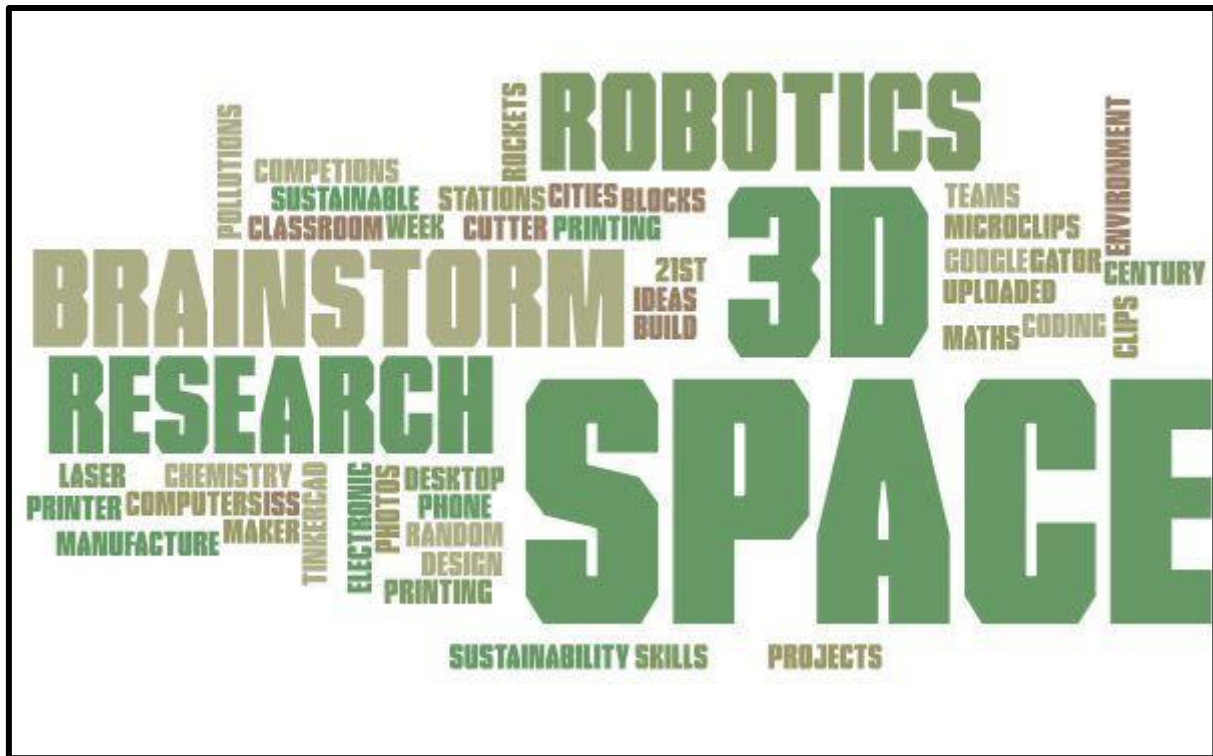A wordcloud representing the various activities in Ireland is shown in Figure 16.

Figure 16: Wordcloud of Irish activities

3.5.4 The Swedish context

3.5.4.1 Participants

All together there were six classes from two secondary schools that participated in the project. The classes were from schools situated in two different municipalities in the mid-west of Sweden, one in Karlstad and the other one in Grums. The students were in grade 7-9 (aged 13-15 years). There were 114 students who participated in the pre-questionnaire, 93 of these responded to the post- questionnaire (the others were not able to respond because of the Covid situation). In total, there were 14 groups of students who took part in focus-group interviews after they had participated in the activities. In each group there were five students, in total, 70 students were part of this data collection.
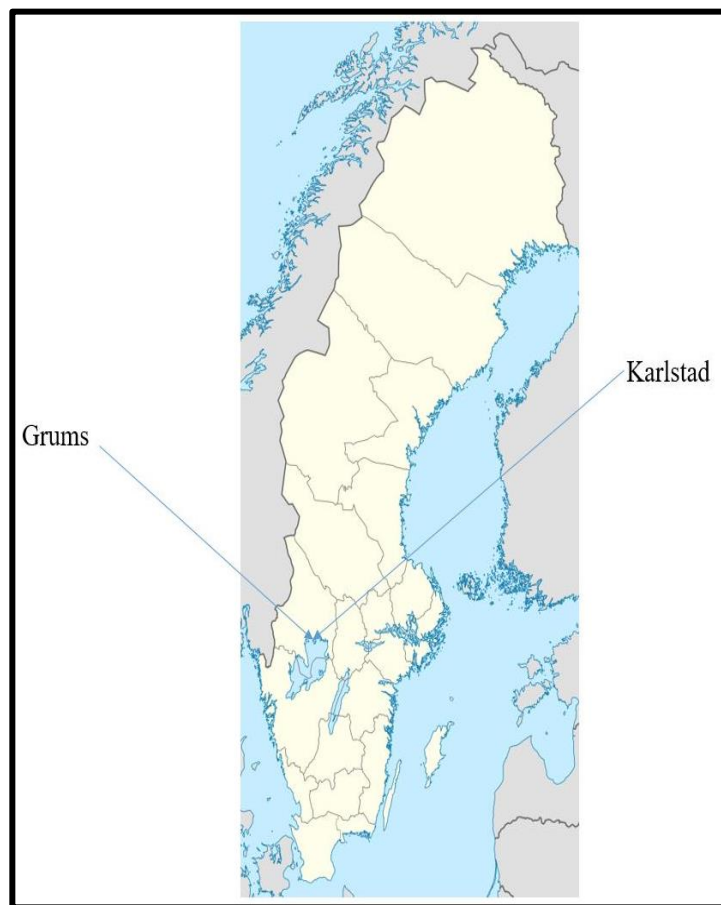
Figure 17: Map of Sweden, showing the location of the two municipalities Karlstad and Grums (20km apart), where the pilots took place.

Four secondary teachers, teaching science, mathematics and technology participated. All of them are women in the ages of about 45 years and with many years of teaching experience. The teachers were interested in makerspaces and had previously been involved in an Erasmus project about makerspaces. In that project they expressed a particular interest in finding out how to assess outcomes of makerspace activities and therefore they found it interesting to be involved in this project. One of the teachers unfortunately could not participate in the project all the way through, hence when referring to data collected from the teachers, we refer to three of the teachers.

3.5.4.2 Makerspace activities

The makerspace that was involved in the maker activities in Sweden is a non-formal makerspace, but the activities took place in classrooms in the schools and at a university nearby, where maker activities for school classes (arranged in collaboration between the makerspace and the university) usually take place. The reason for this being that the makerspace localities are too small to gather school classes.

The maker activities were planned together with the teachers, staff from the makerspace and the person responsible for the pilots in Sweden and a fellow colleague from Karlstad University. It was decided that the teachers could choose what kind of maker activities they wanted to work with, as well as when, and for how long periods themselves, with one exception, the final activity. This was decided to be an activity for all classes, taking place at the university localities working with creation of digital games in Roblox. How long and what kind of maker activities the school classes participated in varied before this final maker activity.

Two of the classes (the ones from Grums) worked with programming activities (Scratch and Microbits). They worked with the activities for two weeks in 80-minute lessons, in total, during four lessons. The activities were led by their teachers (teacher A and B). Both teachers chose short duration and to use the Assessmake21 tool after the making activities (the 3rd approach).

The third teacher (C) worked with a longer project with her students in grade seven (class 3 in the list above). This project lasted during 13 lessons, (à 80 minutes) and was focused on design processes with students creating packages for liquids. Pictures from this project are shown in Figure 12. The teacher chose short duration and the 3rd approach of the Assessmake21 tool.

The fourth teacher (D) decided to work with her students for two weeks, also with the design process at focus, but this time with a challenge to the students to create a digital application (app). The students worked at 80-minute lessons, twice a week with the project. As noticed, the teachers decided the activities that took place in their classrooms, it was not up to students to choose freely what kind of activity they were supposed to do. However, the solutions to the tasks were free for the students to decide. Teacher D had three classes that participated in the project. She chose short duration for all classes but wanted to try all three approaches of the Assessmake21 tool, so she made one of the classes for the 1st approach, one for the 2nd and the third class to use the 3rd approach. The common and final activity for all classes were as already mentioned, about creating games in Roblox. During the Roblox activity all used short duration and the 3rd approach of the Assessmake21 tool. This activity lasted for one full day. Pictures from the Roblox activity are shown in Figure 18 and Figure 19.
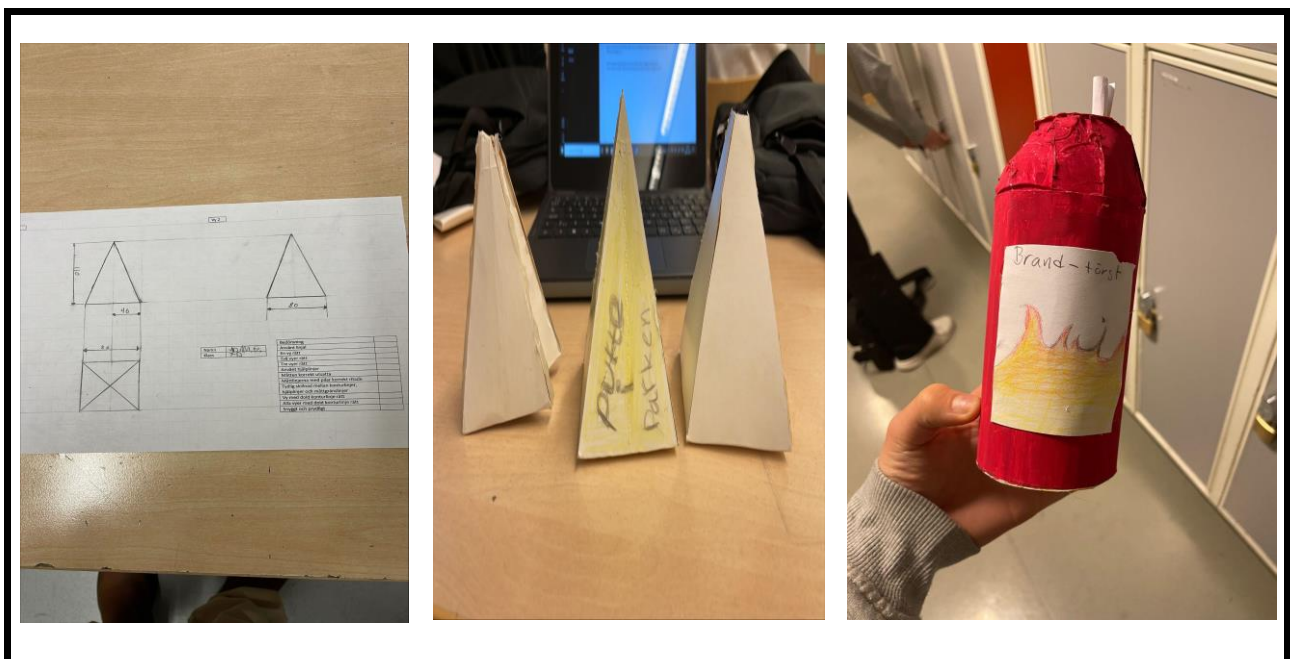
Figure 18: Pictures from maker activities where students created packages for liquids for a music festival

Figure 19: Pictures from the Roblox activity where students created games

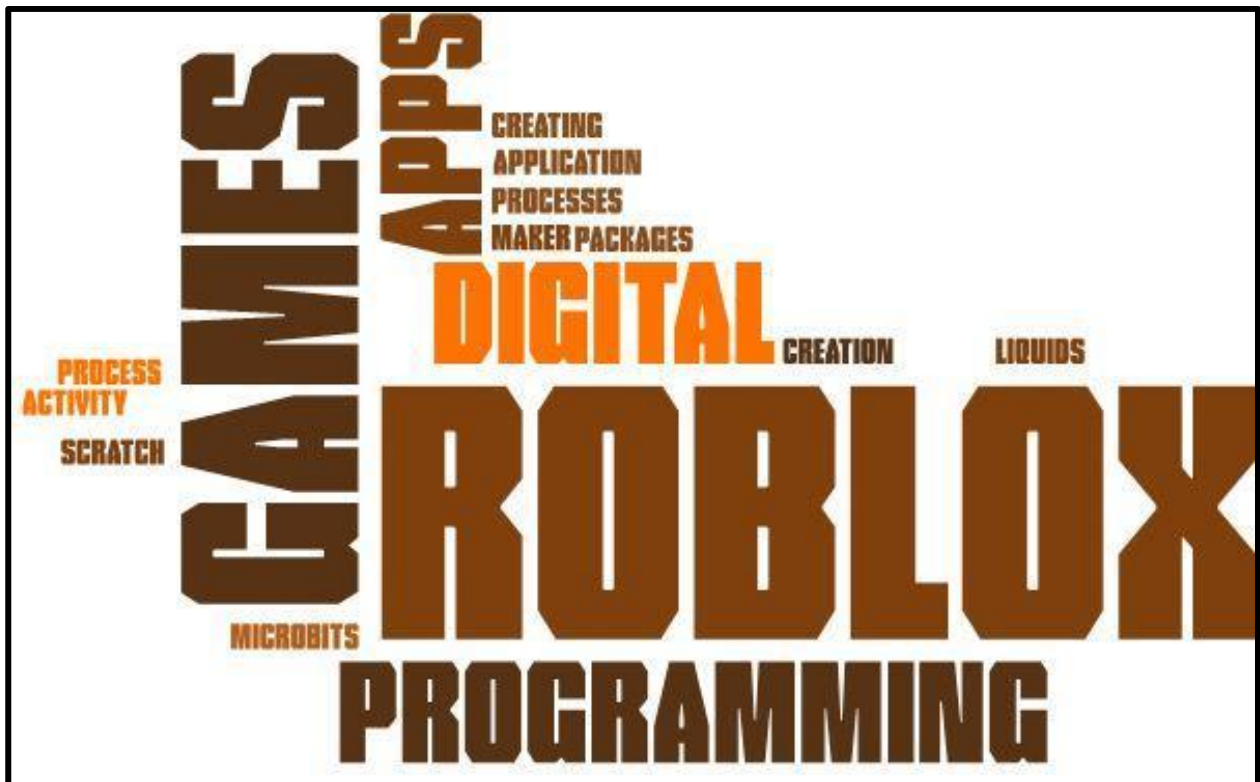A wordcloud representing the various activities in Sweden is shown in Figure 20.

Figure 20: Wordcloud of Swedish activities

4 Results

So far, we have presented the national contexts and the kind of maker activities that have taken place in each of the four partner countries. In this section, we will present the outcomes of the pilots where the Assessmake21 tool was tested in connection with the described maker activities.

The following main questions guided the evaluation of the pilot studies:

➢ *How did the a) students and the b) teachers use the Assessmake21 tool?*
➢ *How did the a) students and the b) teachers experience the use of the Assessmake21 tool?*

Firstly, we present some overview of data directly from the Assessmake21 tool with graphs that cover results from all four countries. In the next sections we present the responses to these questions based on data from each of the partners and their national perspectives even more elaborated.

4.1 Student Usage of the Assessmake21 Tool

In this section we will present data from overall use of the Assessmake21 tool during the pilots. This information will mostly consist of statistics and graphical representations of the tool usage. By presenting these graphs we want to highlight the engagement from students across the pilot sites. In addition, the graphs provide an overview of similarities and differences between usage patterns in the four countries where the pilots took place.

4.1.1 Active Student Users

Overall, there were 301 active users (those users who logged in and conducted at least one session) across the four pilot countries. The breakdown of the users between the countries is show in Figure 21. On top of the 301 active users, there were approximately 25% additional users who logged in but did not use the tool. These 301 students completed a total of 1282 use sessions.
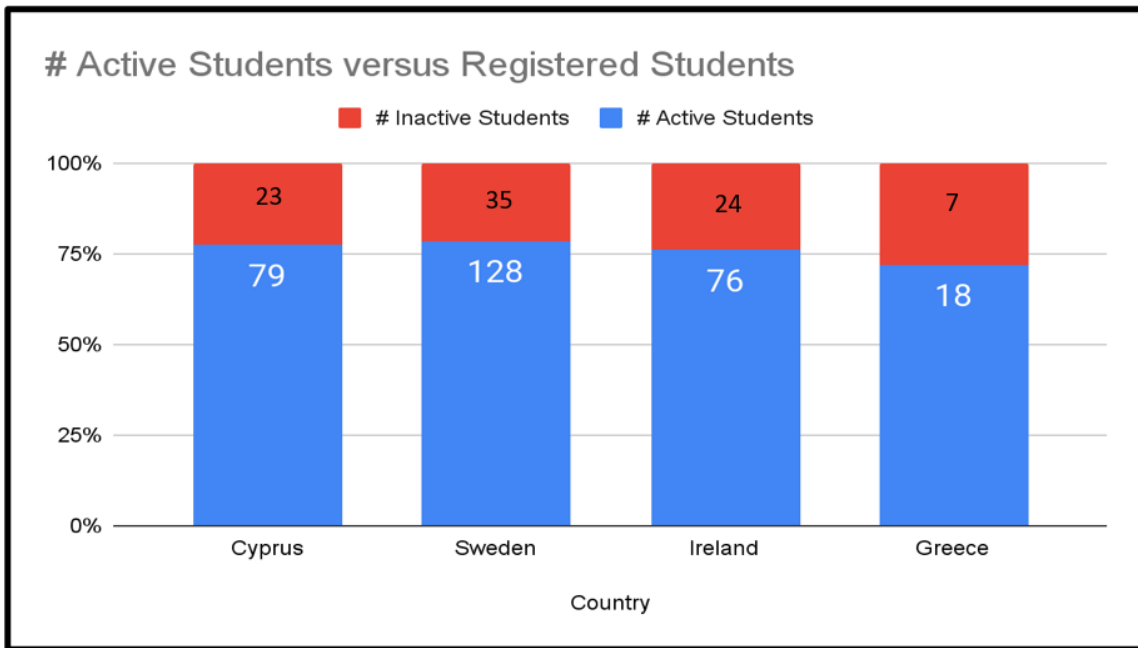
Figure 21: Active students versus registered students in each of the four countries. The active users are shown on the blue scale with the white text, while the inactive users are shown on the red scale with black text

4.1.2 Usage Activity across Pilot Period

In terms of usage over time, the biggest spike in activity occurred in the period covering November and December 2021, when the trial kicked off in earnest. While the Swedish, Greek and Irish trials reached their conclusion by March 2022, the Cypriot trial continued with strong activity until the end of May 2022. This usage pattern is illustrated in Figure 22.
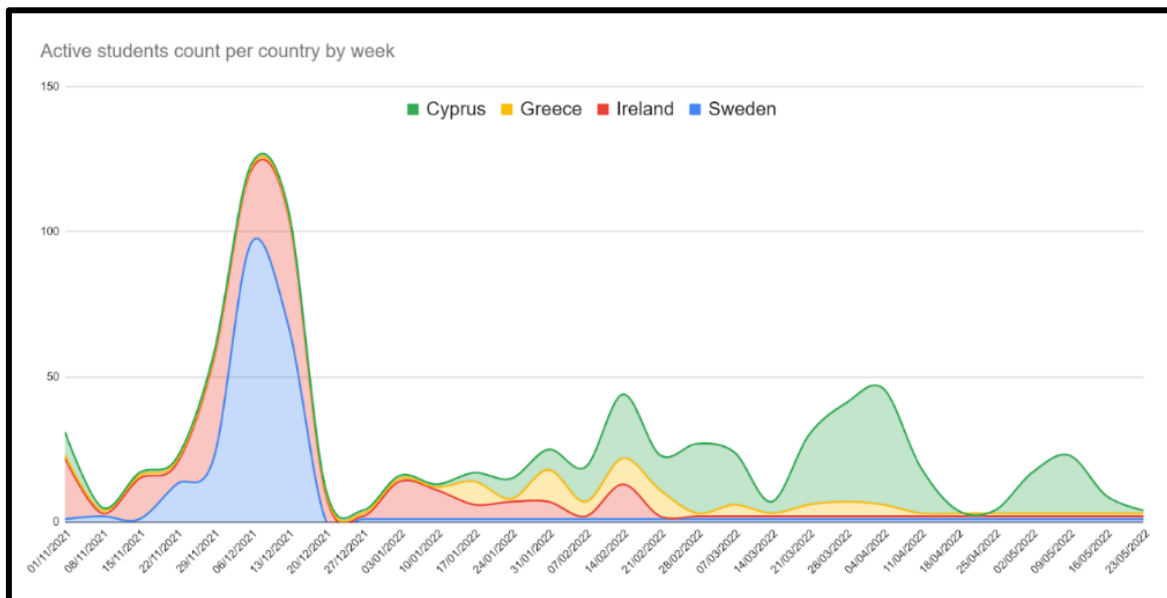
Figure 22: Chronological usage pattern of the tool across the four pilot countries

4.1.3 Tagging Activity

In total, students carried out 4602 tags. The total tags per country and the breakdown of how the tags were distributed across the five taggable skills of Life/Social, Problem Solving, Communication, Creativity and Collaboration is illustrated in Figure 23.

Figure 23: Number of tags on each of the five skills in the Assessmake21 tool

The average tags per student, which gives a sense of usage of a typical student in each pilot country, is illustrated in Figure 24.
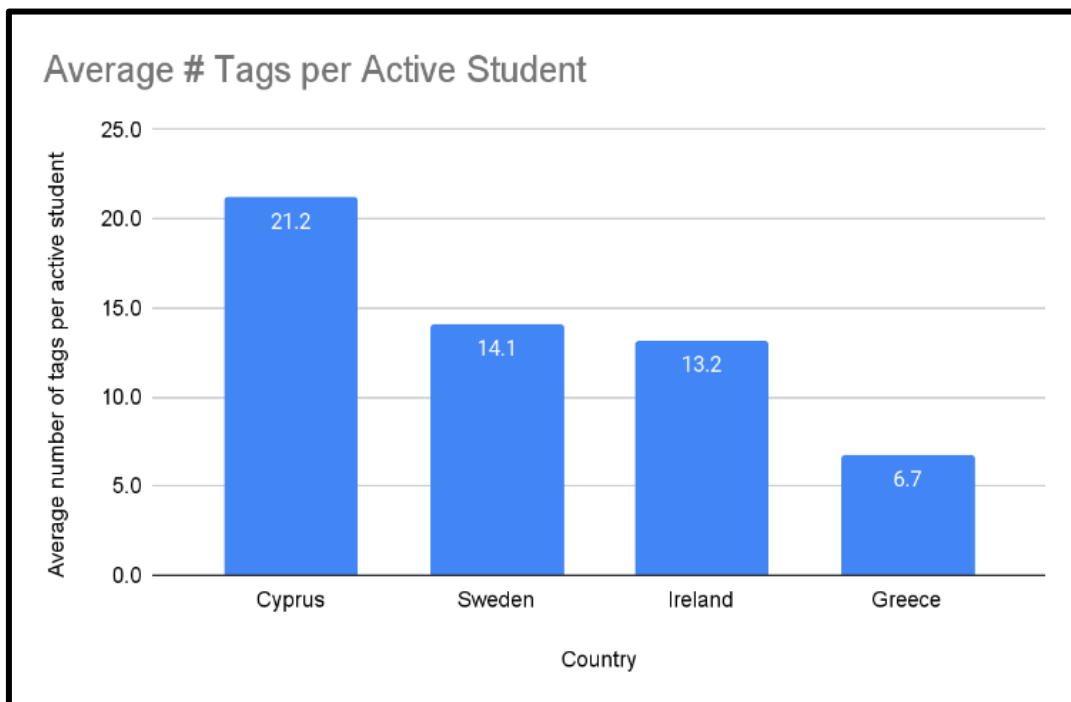
Figure 24: Average Tags per student across the four countries

4.1.4 Examples Uploaded

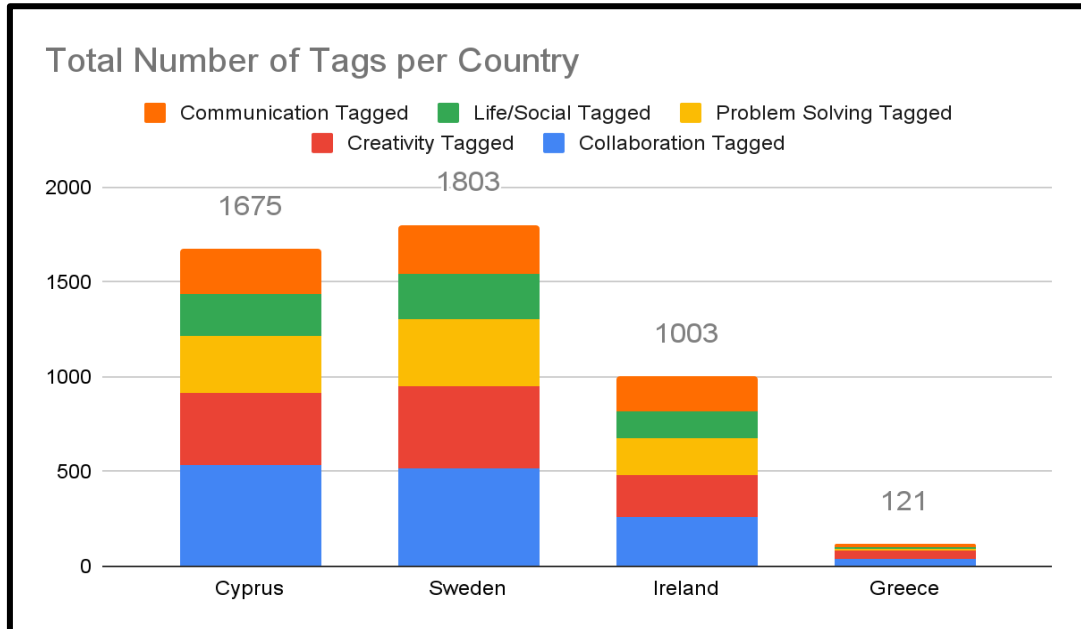During the pilot, 788 examples of the use of 21st century skills were uploaded by students. The breakdown of these uploads and how they were distributed across the five skills are illustrated in Figure 25.
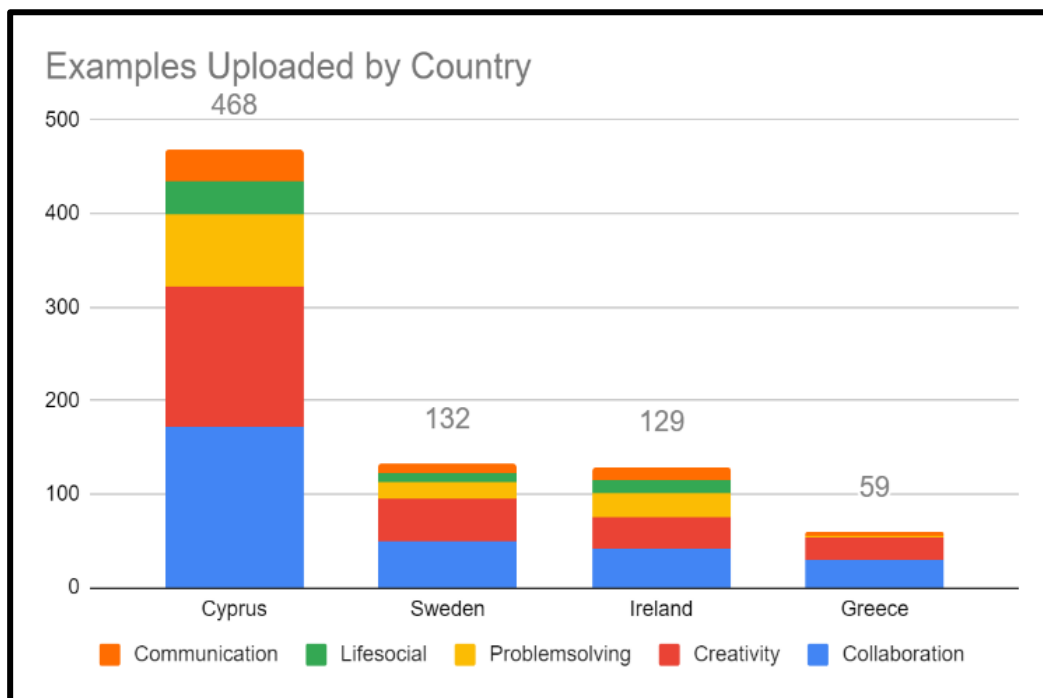
Figure 25: Examples uploaded by country and distributed by skill

The images below show a number of uploaded examples from different countries. This gives a good idea of what the students were working on while using the assessmake21 tool. We provide at least one example for each of the five 21st century skills.

In Sweden, we see an example of collaboration, where students are discussing together how to design an obstacle course.

In Greece, we see a more 'hands-on' example of collaboration, with students sitting together and cutting out paper prototypes the design of a coffee shop.

In Greece, we see students using creativity to brainstorm their next design prototype.

In Ireland, we see students using problem solving skills to overcome a challenge related to Tinkercad, a tool they were using to design 3-D parts for one of their prototypes. This example shows that student were also able to tap in learning resources during the Makerspace, so that they could solve a problem.
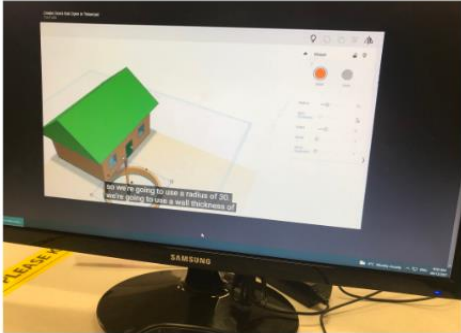
In Cyprus, we see students describing how they had to present their prototype to the class, an example of the use of Life/Social Skills.

Finally, in Cyprus we see an example of communication. In the caption the student has written that they discussed as a group how to come up with a solution for the Lego prototype. When asked why this is a good example, the student says that by communicating you can achieve results more easily (i.e. quicker).

4.1.5 Badge Requests

The Assessmake21 tool includes different levels of challenges for students to take and after completing each level it is possible to request a badge. During the pilots we find that most students requesting a badge did this at the first level with only of few continuing for higher levels. This may be a result of the limited time of the pilots in some of the countries, whereby students did not have time to transition through all the levels for each skill. Given that collaboration was the most tagged skill, it is natural that collaboration was also the most achieved badge. These data are illustrated in Figure 26.
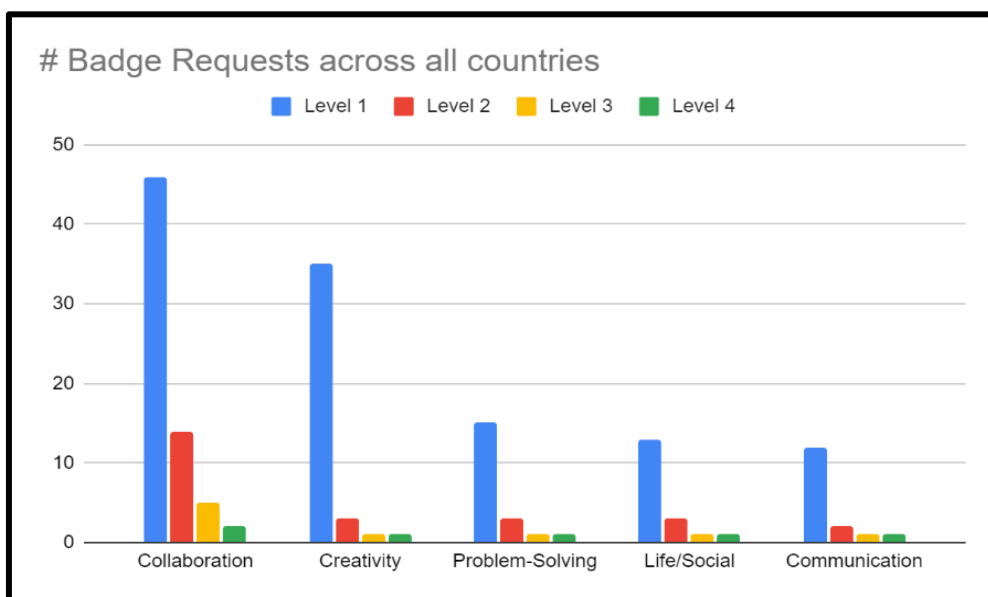
Figure 26: Badge request across skill and level

4.1.6 Summary of Statistics

We can sum up all the statistics related to student usage of the Assessmake21 tool in the dashboard shown in Figure 27.
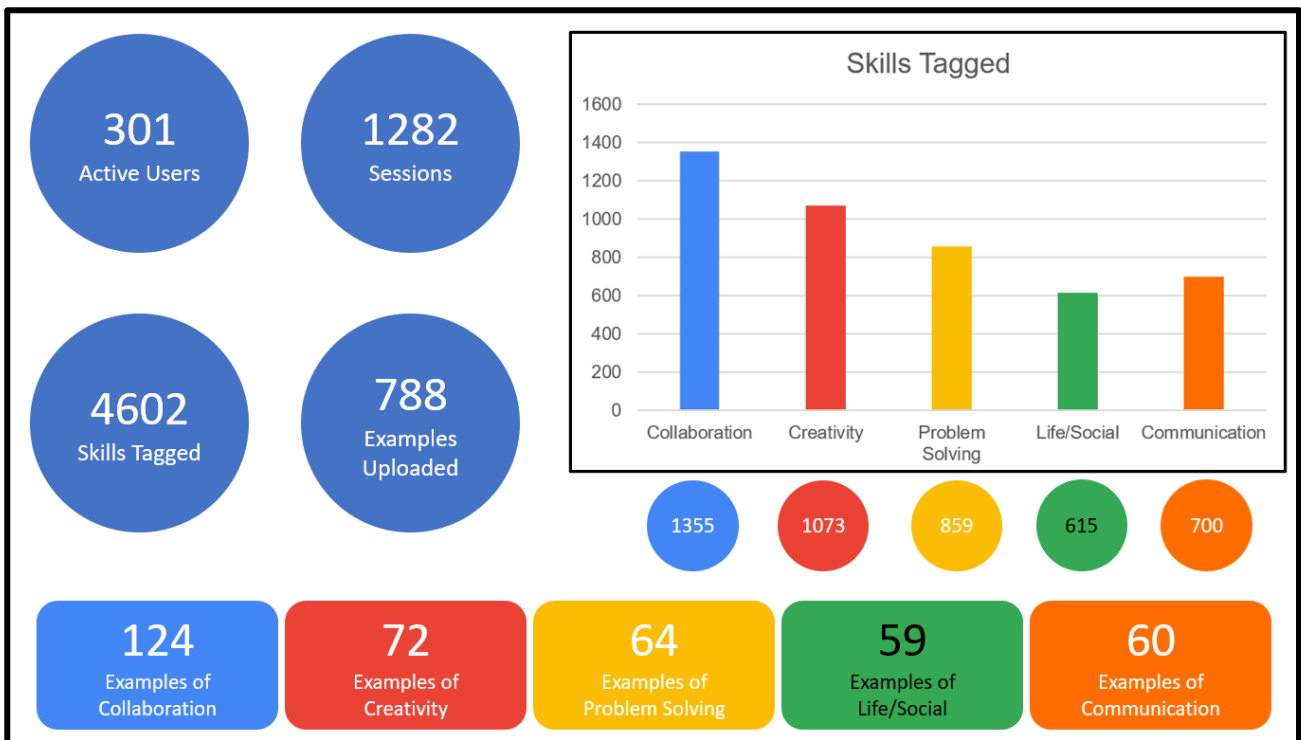
Figure 27: Summary usage statistics across pilot

Dashboards for each country are shown in Figure 28. It is interesting to note the similar pattern of skill tagging distribution across the countries, with Collaboration and Creativity always the most tagged, while Problem Solving and Life/Social Skills always the least tagged. This may show a) a lack of understanding of students of when they are using certain skills b) misattributing the skills they are using, c) unable to recognise when they are using a certain skill, d) tagging collaboration and creativity is most convenient because of the order skills are listed in the app.

Cyprus

Greece

Ireland

Sweden

Figure 28: Usage stats dashboard for each pilot country

4.2 General Student Experience with Assessmake21

In this section we will present the experience of the students with the Assessmake21. While in section 4.1 we looked at how students used the app, in this section we want to get a feeling on how students perceived the use of the app and if it affected their perception and understanding of 21st century skills.

4.2.1 Understanding of 21st Century Skills

Firstly, we take a look at how the students' experienced that the Assessmake21 tool was helpful to support their understanding of the five 21st century skills that are involved in the tool. Therefore, we need to compare their responses to their understanding of the skills before and after participating in the maker activities and using the tool. In Figure 29, mean values of students' understanding of the 21st century skills from the pre- and post-questionnaires across all countries are presented.
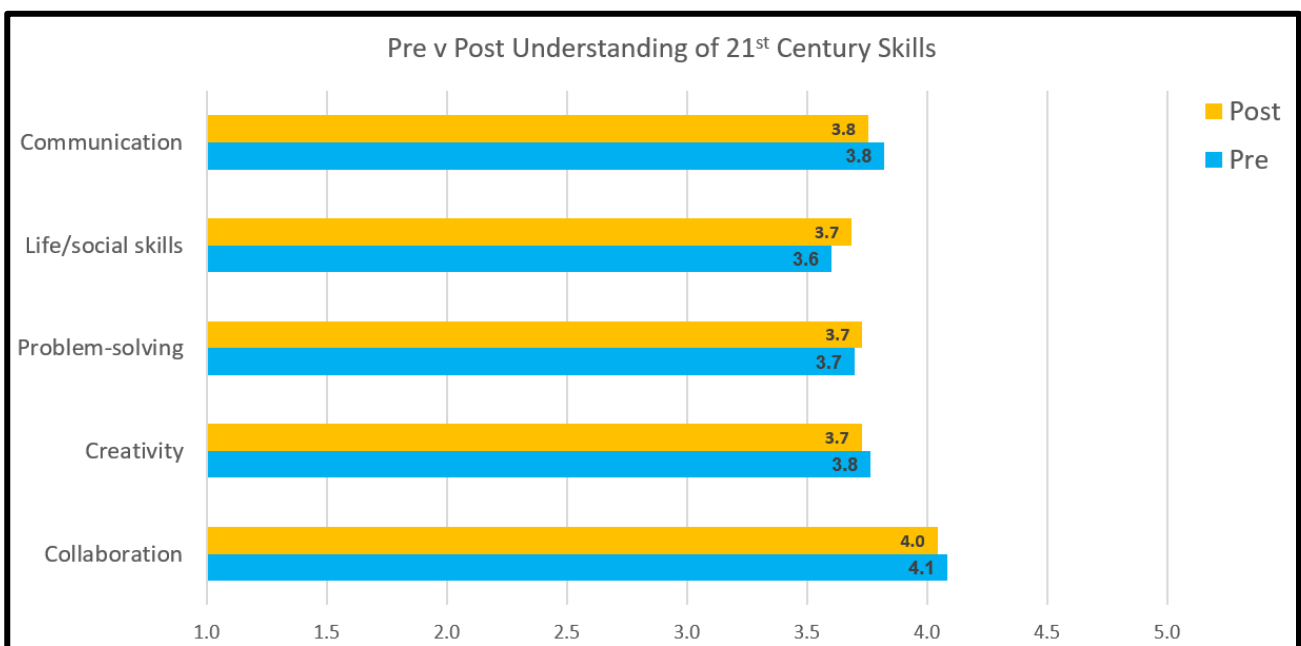
Figure 29: Pre and Post Understanding of 21st Century across pilot as a whole

These means held for the individual pilot countries with no statistical significance. The data from each country can be examined in Appendix II (Section 9). Based on the data derived from the pre- and post-tests, it appears that there is a *no significant change* in students' understanding of the individual skills after the use of the Assessmake21 tool.

4.2.2 Change of Mind

The students were asked in the post-questionnaire if they had changed their mind about what is meant by the individual 21st century skills. We felt it was more useful to show the actual distribution of responses across strongly disagree to strongly agree than to show averages. The pilot wide response to this question is shown in Figure 30 below, while the data from the individual countries is shown in Figure 31.
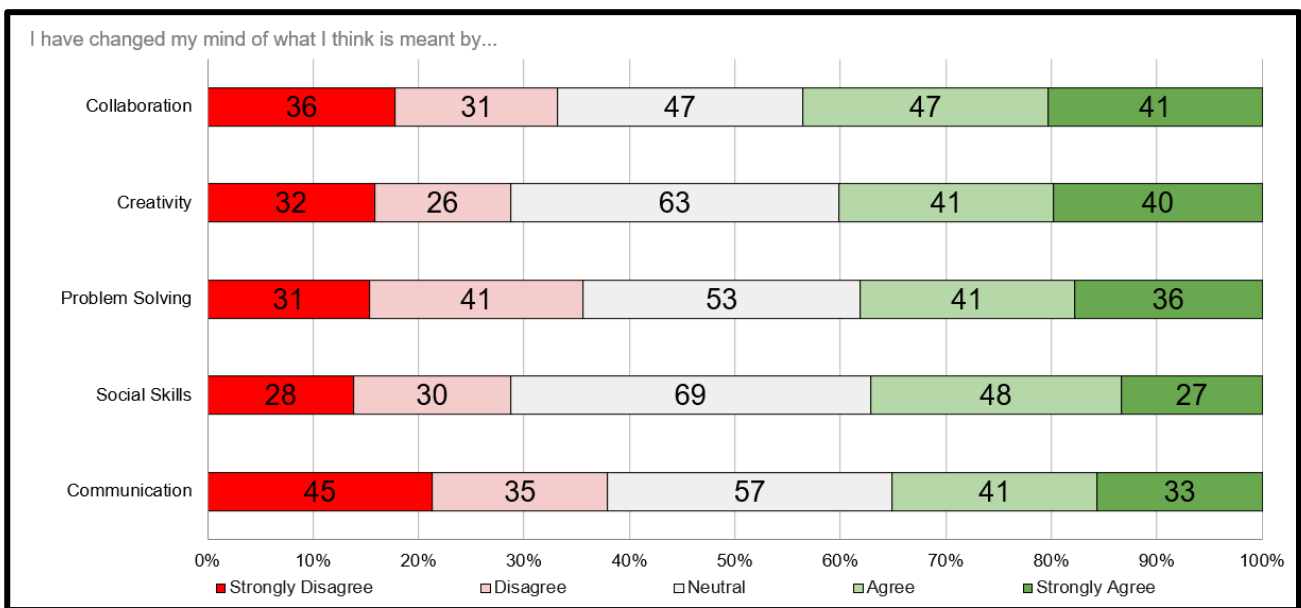
Figure 30: Responses across whole pilot on whether students have changed their minds about the understanding of the 21st century skills (N=202)

Cyprus (N=62)

Greece (N=25)

Ireland (N = 22)

Sweden (N= 93)
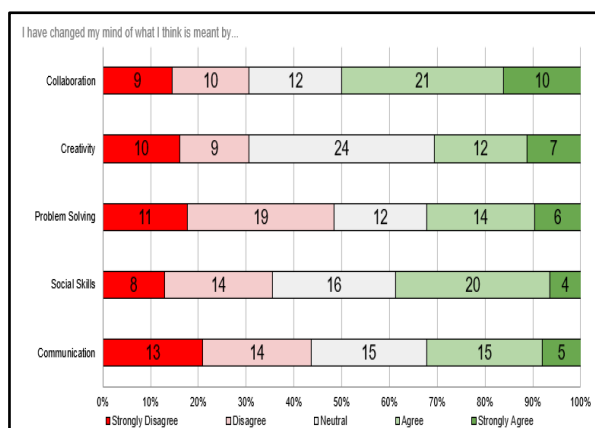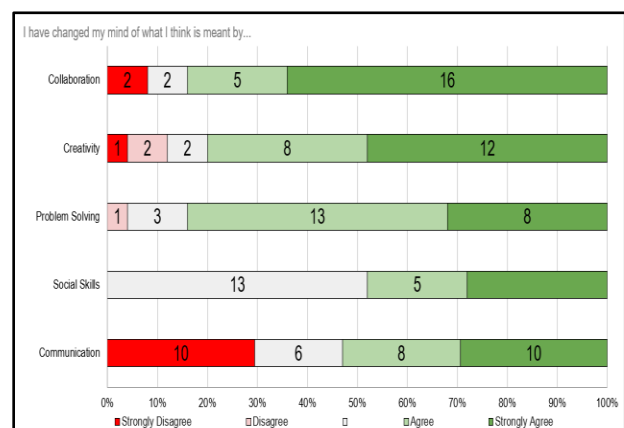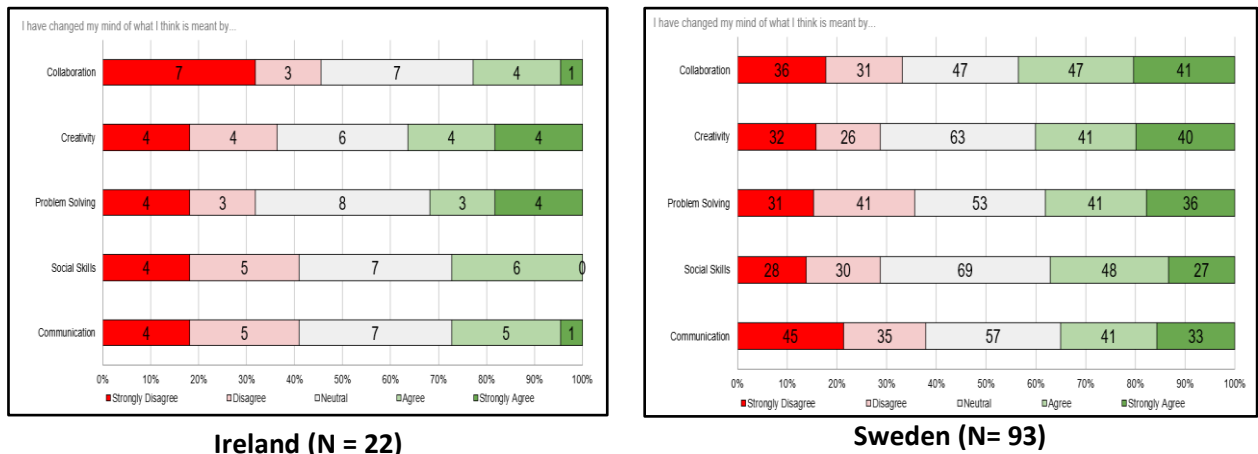
Figure 31: Responses by Country on whether students have changed their minds about the understanding of the 21st century skills

4.2.3 Ease of Use

In order for a new tool to be successfully introduced into new environment in a specific context of use, it must achieve high standards of usability and ease of use. Therefore, we were interested in students' experiences of the Assessmake21 tool based on if they found the tool easy or difficult to use and also the emotional perspective of using it. Figure 32 show mean values for the questionnaire items which asks for students' perception of helpfulness, difficulty, fun and boredom while using the tool. Higher values indicate stronger agreement with the statement.
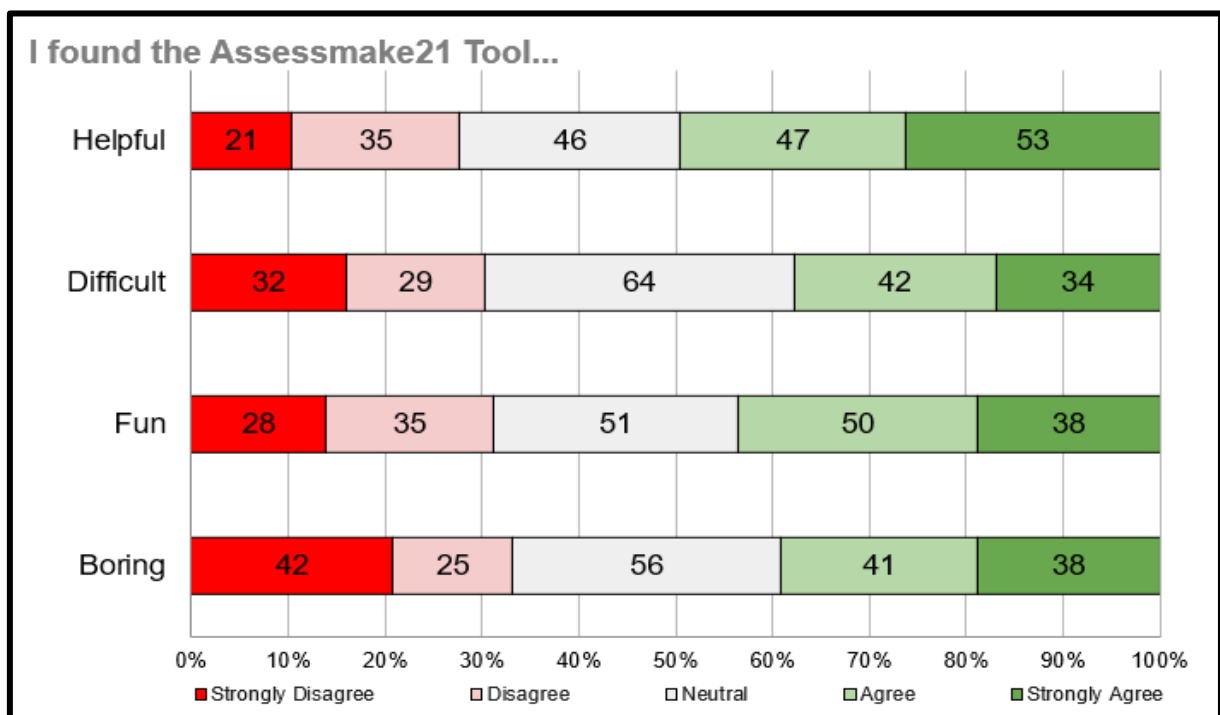
Figure 32: Responses across whole pilot on whether students have changed their minds about the understanding of the 21st century skills (N=202)

The breakdown of these results according to the pilot countries in illustrated in Figure 33.
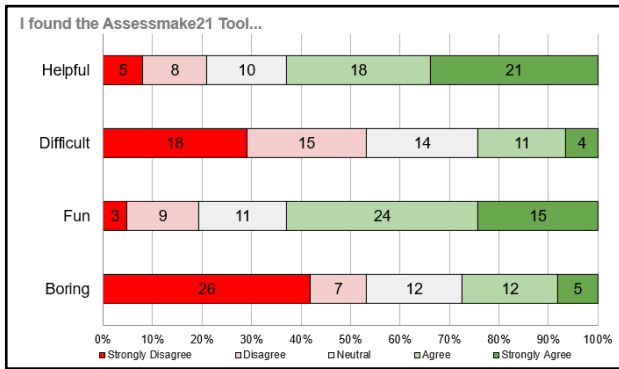
Cyprus (N=62)
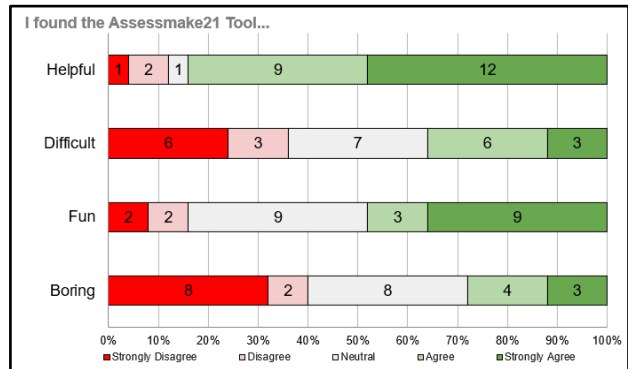
Greece (N=25)
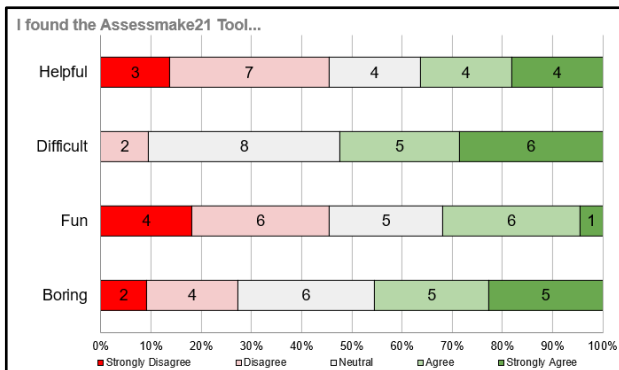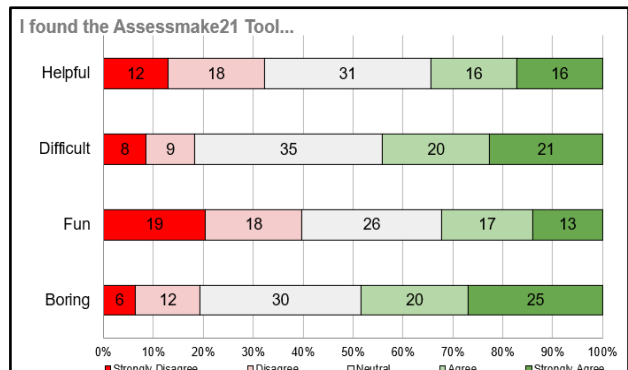
Ireland (N=22)

Sweden (N=93)

Figure 33: User Experience with Assessmake21 Tool by country

In Cyprus and Greece students perceived that the Assessmake21 tool was quite helpful and not that difficult to use. While it appears that students in Ireland and Sweden found it more difficult than helpful. In all countries, except for Sweden, the students also seemed to find the use of the tool more fun than boring.

In the following sections we will elaborate on students' and teachers' experiences of the tool from each of the national perspectives based on individual interviews with teachers/educators and focus group interviews with students (for more information about these interviews see Methodology Section and Appendix I).

4.3 The Cyprus Experience

4.3.1 Summary of Experiences

The key highlights from the student perspective of the Assessmake21 tool during the Cypriot pilot are shown in Table 5.

Table 5: Student Perspectives from the Cypriot Pilot

Student Experiences		
Group	**Pros**	**Cons and Challenges**
Formal pilot site	➢ Easy to use the tool ➢ Fun to take pictures ➢ Self-reflection appreciated ➢ Questions easy to understand ➢ Increased awareness of the 21st century skills ➢ Open-ended-questions appreciated	➢ Some skills difficult to understand ➢ Some words difficult to understand ➢ Too many questions ➢ Not appreciating open-ended questions ➢ Time consuming, so random rating ➢ Boring tool
Non-formal pilot site	➢ Easy to use the tool ➢ Fun to take pictures ➢ Self-reflection appreciated ➢ Questions easy to understand ➢ Increased awareness of the 21st century skills	➢ Some skills difficult to understand for students ➢ Some words difficult to understand for students ➢ Open-ended questions difficult especially for younger students ➢ The tool was competing with making projects attention ➢ 3rd approach not positive for students ➢ Educators had problems grasp the concept of the tool ➢ The tool can be an extra workload for teachers

The key highlights from the teacher perspective of the Assessmake21 tool during the Cypriot pilot are shown in Table 6. These insights include teacher perspectives of student experience as well as their own experience, and also include data from observations made by two researchers from Cyprus Interaction Lab during the making activities. These findings are also separated into the two different kinds of site, formal and non-formal.

Teacher Experience		
Group	**Pros**	**Cons and Challenges**
Formal pilot site	➢ Easy to use the tool ➢ Fun for students to take pictures ➢ Self-reflection appreciated ➢ Questions easy for students to understand ➢ Increased awareness of the 21st century skills ➢ Appreciated educator dashboard ➢ Open-ended-questions appreciated	➢ Some skills difficult for students to understand ➢ Making activities more interesting for students than using the tool ➢ Students do not understand how to use the tool ➢ Difficult language for the students ➢ Students preferred picture taking, not responding to challenges ➢ Too many questions ➢ Students did not like open-ended questions ➢ Students find it boring to use the tool ➢ Rating scale in the tool not communicative
Non-formal pilot site	➢ Easy to use the tool ➢ Fun for students to take pictures ➢ Self-reflection appreciated ➢ Increased awareness of the 21st century skills ➢ Appreciated educator dashboard	➢ Difficult for educator to understand students' tool ➢ Open-ended questions not appreciated by students ➢ Time consuming ➢ Students think the tool is just another survey ➢ Using tablets for this was a challenge ➢ Using the tool competes with time for making activities ➢ Difficult language for the students ➢ Using End approach led to too many challenges at the same time. Not positive for students ➢ The tool can be an additional workload for teachers

The key aspects of the pilot activities in Cyprus are described below.

Onboarding

➢ It took teachers time to introduce the concept of the tool to students. One teacher dedicated significant time to introduce the Assessmake21 tool to students by presenting the platform, explaining 21st century skills and their dimensions and sharing a printed sheet with the definitions and dimensions with students to have easy access to when using the tool. (Group 6)

Login and Credential Workflow

➢ The teacher prepared a document with all the students' credentials to help speed up the process of logging in to the system (Group 2)

➢ One teacher prepared the tablets for students, logging in to their accounts, to limit any delays for the class although the teacher remarked that "if I had a larger classroom, I wouldn't be able to do this." (Group 3)

- One teacher would instruct students to get their tablet (labelled with their name), access the Google Classroom, open the relevant tab and tap on the Assessmake21 link to log in with their credentials. (Group 5)
- Each student had their credentials printed with them and they could also view them from a printed sheet with everyone's' credentials on the class whiteboard. (Group 5)

Blended Approaches

- There were some occasions that the self-reflection part was completed at home, in the afternoon, due to limited time in class (Group 1).
- The workflow was not ideal because students would often work on their projects at home, solve any issues there, and come back in class to print any required pieces on the 3D printer, resolve issues that appear and carry on with the manufacture. Therefore, making was mostly done at home and the self-evaluation part was done in class, "they would only take pictures of the results, they didn't remember what they had done at home to write in the (Assessmake21) tool." (Group 4)

Reminders

- In the beginning of the pilots, students would not log in at the beginning of the lesson, unless reminded by the teacher (Group 2).
- The teacher would send notifications to remind students via Teams to complete the self-reflection and wait for their affirmative responses to review their progress (Group 1).
- The teacher reported that students needed an extensive period of time to get acquainted with the Assessmake21 tool. It was necessary at times to remind students to stop and self-reflect, something the students and teachers were not familiar with. (Group 6)

Time Pressure

- Based on the teacher, having the self-reflection part completed in the afternoon, it was considered as "more targeted, truthful, sincere, it was not superficial", since students were not rushed during class to answer any challenges and they were more well-rested. (Group 1)

Use of Educator Dashboard

- The teacher usually accessed the Educator's dashboard after students have completed their daily self-evaluation. During that time, the teacher would approve any badges, check students' skill levels and review their daily progress in terms of what 21st century skills they identified to have developed. This was also used as an opportunity to review students' specific responses and use them as discussion points the next day. (Group 1)
- The teacher mentioned that he would review students' progress and then use this information during the next lesson to prompt questions about the skills and their evaluation. For example, the teacher would ask them "why did you put 4 on Creativity? What prompted you to rate 4?" The teacher felt this increased reliability of the answers. (Group 2)
- After students would finish with their projects and completed their self-evaluation, the teacher would "access the platform to approve any badges and view the chart, as the final outcome of the day". (Group 3)

> One teacher raised the issue of some students not paying attention when reflecting. The teacher said "Some students did not understand in the beginning that I could see their responses and they were giving random answers or taking pictures that had nothing to do with their project." The teacher had to show students she could see their responses in order to resolve this. (Group 6)

Becoming Familiar

> As students kept using the tool, it was apparent that the process was becoming easier and more familiar to them, who "as soon as they entered the classroom, they would grab the tablets on their own, log in and continue with their project as a group." (Group 6)

> As the lessons progressed, the teacher mentioned that students would know that "I'm in my group, I get a robotics set, I get my tablet, I log in the platform, and I begin. They did not need further guidance." (Group 2)

Group Workflows

> Some students were seen using a single student's account to upload a picture of their group's artefact and all contributed to the self-reflection part. It seemed that capturing a photo together and self-reflecting as a group was preferred and reduced time spent on challenges. (Group 2)

> The teacher mentioned an example where "while three students were working on programming their robot, one child did the self-evaluation for collaboration. Another child later on, did the self-evaluation for problem solving when he saw that the algorithm does not work." (Group 3)

> Students were seen at times to discuss which skill they should tap (Group 3)

Student Workarounds

> It was noted that students would engage mostly with the picture-taking challenge in the home page, rather than tapping the skills. (Group 2)

> Students were instructed to tap on a skill when they are using it, however no challenges appeared for students to reflect on. This was due to the fact that students would not tap on a skill more than twice per lesson (minimum tapping number). They had to tap the skill 3 or 5 times to see a challenge. (Group 6)

Misunderstanding and Miscomprehensions

> Students did not fully comprehend the purpose of the tapping, which may have been because of the teacher's misunderstanding. (Group 2)

> The teacher specifically said that "the wording was difficult, but they would not go back to the Definitions tab to see it" so the teacher would remind them what each skill means when interacting with the groups during the lessons. (Group 2)

> Initially, students were instructed to use only the picture-taking challenge during their reflections due to the teacher's misconception of how the tool should be used. After contacting the technical team, the teacher was able to explain the correct progression to students (tapping skills). (Group 3)

➢ Like Group 3, initially students were instructed to self-reflect only by using the picture-taking challenge in the Home page. This resulted in uploading multiple pictures of their work and self-reflecting only through the picture-taking challenge. (Group 6)

Engagement

➢ Students seemed to be unwilling to use the tool, bored, or completely disliked the idea of using the tool after their making activity (Group 5)
➢ In the beginning, students worked fully on their making and did not reflect or seemed to bear in mind the Assessmake21 tool. They were too excited about the making process to use the Assessmake21 tool. They are very immersed in the making project. (Group 2)
➢ Students seemed more interested in 3D-pens rather than the Assessmake21 tool. (Group 5)

4.3.2 Students' Experience

Examples of direct quotations captured from students are presented below, both positive experiences and some challenges. These experiences are summarised in Figure 34 below.

Usefulness

➢ *It was a very fun and interesting experience for me, it was intriguing too, I haven't seen anything like it [...] that you could assess yourself, because normally teachers evaluate us.* (Group 3)
➢ *[...] the tool was really helpful to help us see the skills that we were developing and I think it can support the development of more skills, from a different perspective.* (Group 1)

Ease of Use

➢ *Generally, its use was easy, there was no difficulty to understand what we had to do.* (Group 1)

Liked

➢ *The thing I liked most was when we took pictures, and we didn't describe only with words.* (Group 3)
➢ *[...] I liked the fact that we could write our opinion on our own and express ourselves freely without thinking if we are saying something wrong, I liked that feeling of freedom in the tool.* (Group 5)

Misunderstandings

➢ *[...]we didn't understand problem solving and communication, we tried to develop them, but it was hard to understand them.* (Group 6)
➢ *It was difficult for me to understand, [...] someone needs to explain it to me to understand."* (Group 6)

Difficulties

➢ *The tool had many questions, meaning we had to answer to many parameters and check different things.* (Group 1)
➢ *Because the time would run out, I had to do it quickly before the bell rang for the next lesson [...] last time I did it quickly and I put 3 3 4 4, I was rating randomly to speed up the process.* (Group 5)
➢ *…a little boring.* (Group 6)

Did not Like

➢ *We don't like assessing, writing after the pictures.* (Group 2)
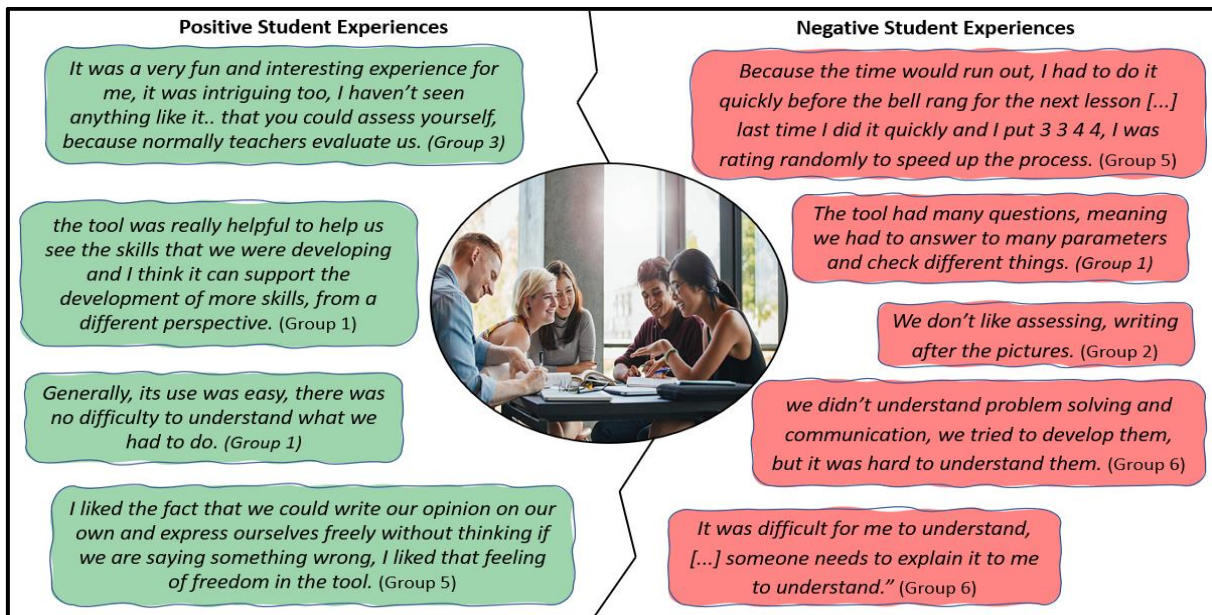
Figure 34: Summary of Negative and Positive student experiences in the Cypriot Pilot

4.3.3 Teacher Experience

When it comes to the positive experiences, there were hardly any differences between the teachers in formal education and educators in the non-formal settings. With one exception, in the formal context, teachers also mentioned the possibility for students to respond to open-ended questions as something positive. In terms of challenges, it was interesting to notice that despite the fact that teachers in formal education thought that it was positive that students could respond to open-ended questions, they also meant that this was problematic/challenging for their students.

Educators from the formal and non-formal context agreed that the language in the tool was too complicated for students and that students preferred to work with the maker activities compared to use the tool.

Usefulness

➢ *It pushes students to an understanding that this tool helps them to develop a skill and students can track their assessment on their own, for instance "yes, I learnt … or no I didn't understand that. Therefore, it helps [...] the student to approach the lesson better in terms of skills.* (Group 4, Teacher)

➢ *[...] in the questions you could say your own opinion, or for example you had to write your own opinion. Personally, I liked it, because you were the one that had to think what to write.* (Group 5)

➢ *It's a lighter approach instead of tests or the typical types of assessment and it's continuous. You have the time to track a student who is falling behind and help him/her. You don't wait for a test or a written evaluation to see something that is not working and then help.* (Group 4, Teacher)

Ease of Use

➢ *The user interface of the tool was really easy and did not hinder the students. This is an advantage.* (Group 2, Teacher)

➢ *I think that it's a complete and nice tool. It has a nice appearance to show how to view each student's progress, the connectivity between the Educator's dashboard and the student's dashboard is direct.* (Group 3, Teacher)

➢ *[...] the questions were simple; they were not complicated. Usually, the difficult part in these questions is the wording, but particularly for this one, it was really simple and easy to understand.* (Group 5, Teacher)

Likes

➢ *The picture-taking challenge was a nice idea, I liked it. This is one of the things students will remember.* (Group 1, Teacher)

➢ *I really liked students getting their badges and moving on! I liked the fact that they were improving, in terms of how they are using the tool but also how they were learning the skills. [...] It's a very important tool and very helpful for us teachers to assess these skills.* (Group 6, Teacher)

Misunderstandings

➢ *The terms were troubling, there were students that were wondering 'what is communication? Is this collaboration?' and they weren't going back to the Definitions to see what they were.* (Group 2, Teacher)

➢ *I think the content of the platform did not help them […] firstly because they did not understand what they had to do […] there were times that I was asking them about collaboration, and they would say "I just put it like that" there was no justification, they just had to complete it [...] some children were doing this superficially to get over with it.* (Group 2, Teacher)

➢ *The last two skills, communication and life/social skills were difficult for students to understand. For example, they didn't select life/social skills to assess.* (Group 3, Teacher)

Difficulties

➢ *The questions should be less for each level, maybe even different, so that it won't be tiring for students. Students were saying, we answered this, how many same questions? Also, the short duration should be shorter than what the one we had; we could get the badges sooner.* (Group 1, Teacher)

➢ *Students had trouble transferring their thoughts into written form, so many times they would ask me "how should I write this?* (Group 3, Teacher)

➢ *The part with the challenges was not very pleasant for students, because they saw it like a questionnaire.* (Group 5, Teacher)

➢ *Some classes have more students, having a tool like this one is an extra workload for the lesson.* (Group 3, Teacher)

<u>**Recommendation for Improvement**</u>

Educators expressed their interest in customising the student experience in terms of levels' duration and specific skills for self-reflection. Here is an example:

➢ *[...] my first recommendation is to make the levels shorter, maybe to create my own levels as a teacher. I can choose to drag and drop, for instance this group to achieve a set of goals, so I will set specific skills. This would entail that the skills are not standard, maybe if I could choose which skills to aim for, select the questions students would have to answer and customize it.* (Group 1, Teacher)

These teacher experiences are summarised in Figure 35.
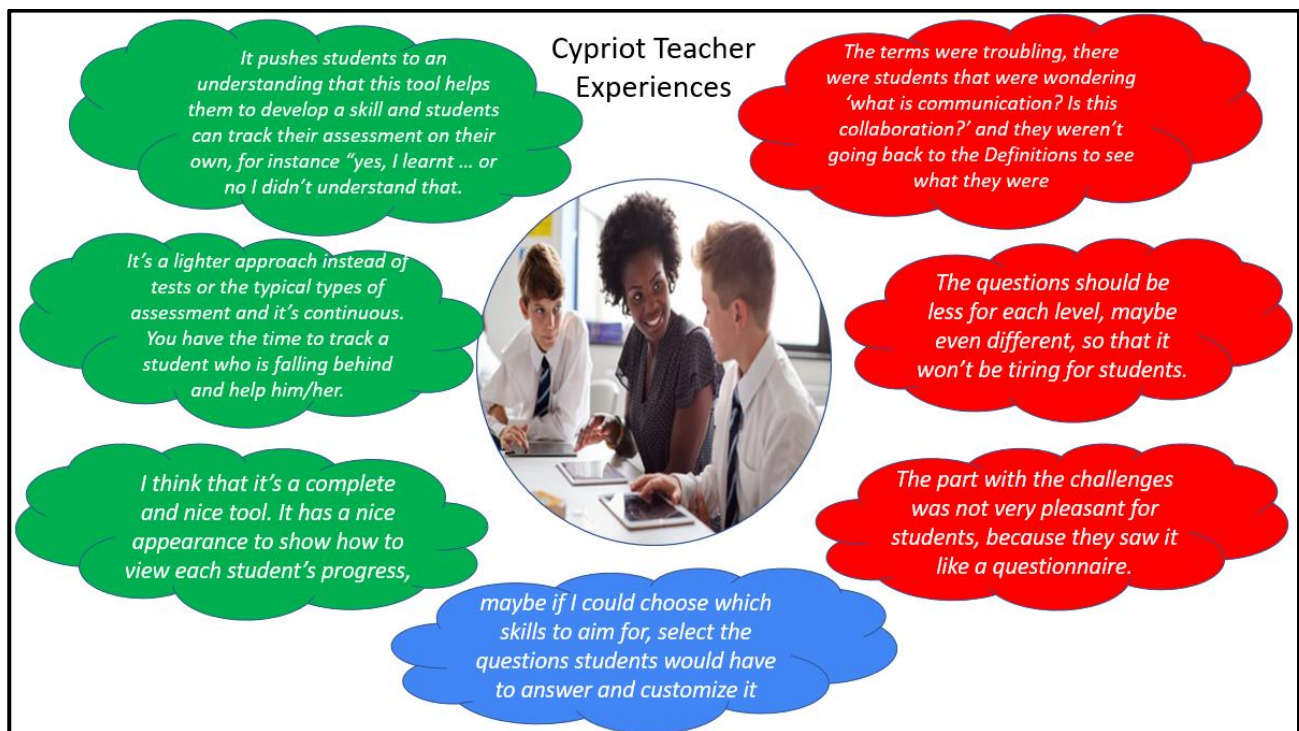
Figure 35: Cypriot teacher experiences

4.3.4 Lessons Learned

The experience of introducing to teachers a brand-new digital tool that affords self-reflection of 21st century skills was incredible. During this time, we have learnt important lessons.

➢ Teachers need more time using the tool as learners themselves, before using it with their students

➢ Teachers need access to 2-3 cases of successful use of the tool in makerspace, to fully realize its use and potential

➢ Language issues (translation to the local language) must be revisited, with the input of educators

➢ The tool works better with older students; older students (15-18) were more engaged and did not experience the challenges expressed by the younger students (12-14)

➢ The use of the tool creates the need for additional teaching and learning time which must be taken into consideration.

4.4 The Greece Experience

Given the sharp difference in context between the formal and non-formal sites in Greece, we report the results separately where possible.

In this section, teachers and students' experiences from the Assessmake21 Greek pilot sites are described together with the context within which they were documented, alongside the challenges, the difficulties and the proposals for re-considerations/ improvements. By presenting the participants' experiences through a realistic framework, we aspire to encourage more teachers (from formal and non-formal education settings, in-training or in-service) to embrace the Assessmake21 initiative and promote the reflection upon the 21st century skill development during the learning and making practice.

4.4.1 Summary of Experience

The key highlights from the student perspective of the Assessmake21 tool during the Greek pilot are shown in Table 7.

Table 7: Student Perspectives from the Greek Pilot

Student Experience		
Group	**Pros**	**Cons and Challenges**
Formal and Non-formal pilot site	➢ The role of the Assessmake21 tool towards setting goals, progress monitoring and 21st century skills awareness ➢ Skill transferability into other contexts or subject areas ➢ Gamification practices integrated in the Assessmake21 tool ➢ Overall look of the tool from an aesthetic point of view	➢ Need for a familiarization stage and support in the beginning ➢ Initial reluctance - need for reminders from teachers' side ➢ Too many similar questions/ repetitive questions ➢ Lag issues ➢ Photo upload is problematic and time consuming in PCs ➢ Translation issues in the Greek interface ➢ Back camera did not work in all mobile devices
Formal pilot site	➢ The role of the Assessmake21 tool towards setting goals, progress monitoring and 21st century skills awareness ➢ Skill transferability into other contexts or subject areas ➢ Overall look of the tool from an aesthetic point of view	➢ Too many similar questions/ repetitive questions ➢ Photo upload is problematic and time consuming in PCs ➢ Rating scale 0-4 was confusing ➢ Not clear when a session ends (approach 3) ➢ Need for progress graphs in the students' interface ➢ Complicated language in both Greek and English interface

The key highlights from the teacher perspective of the Assessmake21 tool during the Greek pilot are shown in Table 8. These insights include teacher perspectives of student experience as well as their own experience.

Teacher Experience		
Group	**Pros**	**Cons and Challenges**
Non-formal pilot site	➤ Recognizing the role of the Assessmake21 tool in relation to 21st century skills development and awareness ➤ Identifying connections with the curriculum/ of added value in different subject areas ➤ Identifying the reinforcing/motivating role of badges	➤ Need for a familiarization stage ➤ Need for reminders to use the tool (especially in the beginning) ➤ Need for fewer and bigger buttons ➤ Need to become available as a mobile app ➤ Wording and language issues ➤ Pilots and participation challenged by covid-19 ➤ Not all the skills were grasped at a certain level
Formal pilot site	➤ Recognizing the role of the Assessmake21 tool in relation to 21st century skills development and awareness ➤ Identifying connections with the curriculum/ of added value in different subject areas ➤ Aesthetic style/look	➤ Need for a familiarization stage ➤ Skill definitions are missing from teachers' dashboard ➤ Extra workload for teachers in formal education (where the timeframe is really tight) resulted in not exploring all the available features in teacher's dashboard (i.e., allocation of badges) ➤ Tensions between school program and use of the tool within school subjects ➤ Change scaling in challenges ➤ More open-ended questions ➤ Wording and language issues ➤ Provide students with more feedback on their own progress ➤ Not all the skills were grasped at a certain level

The key aspects of the pilot activities in Greece are described below.

Onboarding

A familiarization/preparatory stage took place in both the non-formal and formal contexts. This was considered important for the smooth introduction to the tool. This stage was used to ensure that all the participating students had a certain understanding of the process to be followed, and to demonstrate the use of the tool.

Utilising Different Approaches

The educators utilised different approaches depending on the activity. The first approach was used while the first maker activity was work with creating paper circuits, while the second approach was used in the second project to better facilitate the nature of the project which was designing and printing everyday objects

> *[...]For the 2nd project I decided to activate the 2nd approach to avoid distracting students from the 3D modelling process. I realized that it might be distracting to pause the 3D modelling process to take challenges in the tool. Having the parallel tapping and moving the challenges in the end was more convenient for this type of project. In a way, the type of projects informed the selection of the approach"*
> (Educator, Greek non-formal pilot site)

Reminders

In the beginning teacher's support was crucial. Reminders to use the tool were also necessary in the beginning as *"this was a new practice for students"*. However, the more they practiced the tool, they became more accustomed to using it, minimizing any need for educator's intervention.

Use of Different Devices

They used PCs, tablets and mobiles during the pilot phase. However, they ended up using mainly tablets as they could ensure a better user experience.

Translation Issues

Due to translation issues with the Greek interface, the teacher decided to work in the English interface in order to avoid postponing the beginning of the pilots and jeopardising losing students' interest. This was not an issue, given that the school is international, and they work in both English and Greek.

Difficulties

As the use of mobile devices was not permitted in the school, they used PCs to run the pilots dealing with significant difficulties related to photo upload.

Time Constraints

Within this tight school timeframe, the use of the tool was an extra workload for the teacher. In the formal pilot site, the deeper exploration of the available features and the keeping of track of recent updates and the improvements in the dashboard were jeopardised. For example, the teacher did not allocate any badges to the students nor very frequently was checking their progress.

4.4.2 Students' Experience

From the data presented in Section 4.2 we were able to derive some further insights of the student experience:

➢ It seems that the participating students closely relate the tool with the opportunity that it offers for reflection upon their own learning.

➢ There is also an agreement that the tool is fun to use.

- Based on the results of the questionnaires, it seems that students disagree that the tool was difficult to use. However, this contradicts with the results from the interviews where there is a general agreement that a familiarization stage and support from the teacher/educator is essential in the beginning. Either the students do not recall initial struggles (for which they have also proposed some solutions) or the familiarization stage worked well towards significantly improving their user experience

We can also present some more insight based on direct quotes from students as obtained from the post pilot focus groups. The perspectives gained from students during interviews were codified under a number of themes as presented below.

Recognising the role of the Assessmake21 tool in relation to 21st century skills development

During the focus group interviews, students tried to relate the role that the Assessmake21 tool played in relation to 21st century skills development and awareness. Some students directly related the reflection upon the skills with the use of the tool whereas others highlighted the fact that the making projects themselves plays a critical role towards skill development, concluding that the tool has a contributing role towards reflection. Encouraged to describe **what the Assessmake21 tool is about** based on their experience, a number of quotes were received, here are a few examples:

- *"A tool that allows us to self-evaluate ourselves" (team 3, non-formal pilot site)*
- *"Using the tool, we could realize what went wrong, which aspect of personal or team work we could improve and how we can become better" (team 4, formal pilot site)*

When prompted to refer to specific skills that they developed or improved, the majority of the students mainly referred to the skill of collaboration and creativity. There is also an indirect reference to the skill of communication as well as social skills when they are referring to the way they worked together, overcame challenges and negotiated how to work on their projects. Some examples of student comments:

- *"Well, I did not know that I can call myself a creative person…so each time I was uploading a picture I was realizing that I have achieved something…for example all these things that we designed in TinkerCAD. I did not know that this was a creative work…I could not even imagine. Of course, TinkerCAD with all these features helped in this direction but I can say that I personally manage to improve my skills in creativity and collaboration and be more social in the team"* (Team 2, non-formal pilot site).
- *For me, I believe that teamwork was practiced more... teamwork, cooperation... you cannot create something in a team without good cooperation... at all levels... so I think this is one of the skills that developed a lot.* (Team 4, formal pilot site)

Fewer students referred to problem solving and life/social skills, however there are few signs (based on interviews) that the tool supported their reflection upon these skills as well. Noteworthy, there is no sign that the five skills were grasped at the same level, and this is also confirmed by the teachers from both pilot sites.

- *"I learnt to deal with problems and better understand them and to find ways to overcome disagreements…to come up with a solution that makes the team members happy. I feel more*

creative. I have more ideas now. And I am more willing to collaborate with my classmates [...]"
(Team 2, non-formal pilot site).

Overall, although a new practice for the participating students, most of them seemed to realize that the Assessmake21 tool can encourage the development and the reflection upon 21st century skills, no matter how deeply each of the skills is explored. They connect the tool with a reflective journey upon the progress that has been made during the making sessions. There are also clear signs that the tool boosted self-assessment and self-improvement and had a positive impact on the way they worked with each another, setting a basis whereupon teamwork can be also benefited.

Nevertheless, there were few students who mentioned that "*in some cases the tool was unnecessary and had nothing more to offer*" and few others who felt that *'it was a bit boring'* and needed a boost or a new motive in order to continue using it.

Skill transferability into other contexts or subject areas

In some cases, students seemed to recognize that the tool could be applied in other subject areas, activities, and contexts, even beyond school activities. Students mentioned that the tool helped them develop "*the needed social skills that are essential in school and in society.*" Some mentioned that the tool can be used in other subjects as well, "*not only in subjects with a practical and a 'creative' aspect, but in every subject in the curriculum",* highlighting the potential benefit of self-assessment in all areas of school.

A specific case involving two students (Student A and Student B for the purpose of the below transcript) is worth examining. The students seemed to recognise that the skill of communication, which was explored and practiced during the Assessmake21 pilots, was later on applied in a more mature way in the subject of Arts. The following dialogue exemplifies this fact:

> **Interviewer:** *You mentioned that the way you communicate has been improved. Is this useful in other subjects or activities outside the school?*
>
> **Student A:** *Personally, I think that it is useful when I am doing artistic projects in school.*
>
> **Student B:** *I agree! Yes! In the Arts class and especially while painting. I learnt how to paint with others due to the fact that I was able to communicate better with them. It was something that I enjoy doing now. I work on artistic projects more efficiently, using new methods and working better with my classmates.*
>
> *(Team 3, non-formal pilot site*

Gamification practices integrated in the Assessmake21 Tool

Most of the students considered the award of badges as a stimulating mechanism towards using the tool further and exploring its potential deeper. Some students identified links with other applications such as Duolingo[2] which integrates similar gamified assessment mechanisms.

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[2] https://www.duolingo.com/

> *Student:* The App reminded me of Duolingo.
>
> *Interviewer A:* In what ways? If I am not wrong, Duolingo is for learning foreign languages…
>
> *Student:* Yes! It has a similar assessment system and I felt that it was very helpful.
>
> *Interviewer A:* So, you felt that this was a familiar practice for assessing what you were doing. Did I understand correctly?
>
> *Student:* Yes exactly! And I do realise how I progress and move from level to level.
>
> *Interviewer B:* Did you also have the opportunity in Duolingo to get a badge, like it happens in assessmake21?
>
> *Student:* Yes, each time you complete a section you get a badge and this is very stimulating and encouraging.
>
> *Interviewer A:* So, what role does the badge in the tool play?
>
> *Student:* It is encouraging and makes me feel nice and efficient! It makes you set goals.
>
> *(Team 3, non-formal pilot site)*

However, it appears that the way the teacher uses the tool closely affects students' experience. The educational potential inherent in the mechanism of requesting and receiving badges is revealed only when badges are indeed awarded. The eight students from the formal pilot site who did not receive any badge (based on their teachers' statement), doubted whether this mechanism was of any added value and instead asked for graphical representations of their progress (i.e., through graphs and statistics per skill).

Overall look of the tool from an aesthetic point of view

In general, students expressed positive comments about the design of the tool which was characterised as *"minimalistic"* by most of them. The selected colouring palette and the logo received positive comments, the same applied to the general layout of the tool with one student highlighting the fact that *"the pages were not stuffed with icons and information, so one could focus on the essentials.*

Working with the tool: Technical issues, challenges and recommendations

An issue raised by the students (in both pilot sites) was related to the challenges and the set of questions addressed to them. These were considered to be too many (no matter the duration that has been activated by the teacher) and described as very repetitive and similar to one another. Some students also mentioned that the flow of the questions did not make sense in some cases nor was related to what they were working on in the makerspace.

> ➢ *"There were too many questions, and in some cases, they were not relevant to what we were doing".* *(Team 3, non-formal pilot site)*
> ➢ *"The questions were too many and it felt at least in the beginning very repetitive and like being generated by a robot". (Team 5, formal pilot site)*

A major issue seems to be related with the challenges that required the upload of photos. This issue was brought up by the students who worked on PCs and was also confirmed by the teachers who took part in the pilot studies. The process was considered difficult and time consuming.

In addition, the students from both pilot sites referred to some technical issues and 'bugs' that they experienced while using the tool. They referred to connectivity problems and the importance of a good internet connection, lagging issues and slow responsiveness. In students' words: "It *took too long to login to the tool after entering credentials*" and "*the tool lagged before loading*". These issues were also pinpointed by the teachers from both sites.

The students also referred to language problems in the interface that affected their experience. Some terms were not easy to grasp or did not make much sense. The fact that in some cases the questions felt too automated and repetitive was again brought up.

> **Interviewer:** *Did you find it easy to use the tool?*
>
> **Student A:** *There were some questions that the translation made no sense*
>
> **Student B:** *Yes, there was a problem there. The translation was non good, something like auto-translation...it was really confusing.*
>
> **Interviewer:** *So, what did you do? Did you use the English or the Greek version?*
>
> **Student A:** *First we tried the Greek version but we could not understand all the questions*
>
> **Student B:** *Yes, and after that we used the English version.*
>
> **Interviewer:** *Was there any problem with the questions in the English version?*
>
> **Student A:** *The questions seemed too automated and repetitive.*
>
> **Student C:** *In some cases, we could not still understand the question…something was unclear there too.*
>
> *(Team 5, formal pilot site)*

This issue was also confirmed by the teachers from both pilot sites. In an attempt to deal with this issue, the formal pilot site worked directly on the English interface, which was considered less confusing. Among the confusing features was also the 0-4 rating scale used in some challenges, with the recommendation for a more appropriate scale:

> ➢ *Something else that is confusing is the sliders…for example regarding "creativity" you have to select from 1 to 4. I think that 4 is not enough…it could be 1 to 8 or 1 to 10…I think that we could evaluate it more precisely[...] With a scale from 1 to 4, between 1 and 2 there is a big gap. The range should be wider" (team 5, formal pilot site)*

Students also provided **recommendations** towards improving the tool and ultimately their user experience. It seems that most of the students recognise that a familiarization stage and teacher's support is necessary as "*at first, it was difficult to adapt to the tool".* This issue was also raised by the teachers who participated

in the pilots. However, it seems that for some students, teacher's intervention/mediation in the form of a *"reminder of using the tool"* was also needed throughout the pilot implementation period.

> *"Our teacher's guidance and support at an early stage made the navigation within the tool easier"* (team 1, non-formal pilot site)

Despite the fact that most of the students seemed to enjoy the navigation within the tool, some students proposed the rearrangement of the buttons in some of the screens and the integration of two additional buttons: a *back button*-to move back to a previous screen and a *skip button* in order to skip a question/challenge based on their needs each time.

Last, there was a recommendation regarding the flow of questions in approach 3 (coming from the formal pilot site). It seems that it was unclear when a session ended and started all over, thereby the students proposed that a relevant pop-up message could improve their experience.

> *I'd love to know when a session ends...a message that pops up saying "thank you... you can leave now..." [...] to be aware when a set of questions starts and when it ends... This way, the site* [referring to the tool] *would be a lot better. In other words, you need to add a page at the end...when we have completed all the questions…"thank you! See you next time"… or a message like this. (Team 4, formal pilot site)*

4.4.3 Teacher Experience

For the presentation of the results, teachers' quotes have been used within the text, in quotation marks ("") and italics. Some teachers' quotes that are worth bringing forward are presented as interview episodes.

21st century skills development and awareness

The participating teachers recognised the tool as facilitating the reflection upon the skills that are practiced during a making session. They described it as a tool that can boost the '*documentation/recording'* of the skills and trigger mechanisms for '*self-evaluation*'. The teachers highlighted the fact that maker activities and the related interactions in the makerspace encouraged the development and the practice of 21st century skills, while the Assessmake21 tool boosted the reflection upon the skills, encouraged the exploration of the different aspects of the skills and finally invited students to enter into a self-assessment and reflective process. The challenges integrated in the tool allowed students to reflect upon their individual skills. Interestingly, the reflection was seen to be extended at group level with the students negotiating whether a skill was developed or practiced. This reflective process was also seen as resulting in self-improvement in some cases.

> *"[...]I think that the mechanism for reflection works well. Before clicking or answering they have to think. Is this the skill I practiced or not? In a way, an internal dialogue is activated, which sometimes was opened up at group level as well. They asked one another 'should I proceed with this skill? What do you think?"* (Teacher 1, non-formal pilot site)
> *"[...]the tool helps students to be aware of the skills they already have and what can be further developed. For example, I liked the fact that some students consciously were thinking upon their skills and were noticed trying to improve their skills from one session to the other [...]".* (Teacher 2, formal pilot site)

Another issue that was raised by the teachers is that it needs time for the students to get used to the tool especially when they are not familiar with such practices. Over a long-term engagement teachers saw how the tool eventually found its way into the routine of the students:

> *'In the beginning I was a bit stressed given that I invited the students to do something they have not done before. But surprisingly, from session to session, my prompts and support were not needed that much. I realized that most of the students took initiative and action when necessary. They were acting on their own'* (Teacher 1, non-formal pilot site)

There was some evidence to suggest that not all the skills were grasped at the same level. This is something that was brought up also through students' interviews. Teachers from the formal pilot site mentioned that the students focused more on the skills of collaboration and communication, and less on the other skills (problem solving, creativity and social/life skills) regardless of whether they were recognised as being practiced during the making sessions. The teacher from the non-formal pilot site mentioned that primarily the skills of collaboration and creativity were grasped better and secondarily the skill of problem solving.

> *'The students worked more on the skills of creativity and collaboration. Let's not forget that they worked in groups and especially in the first project they did lots of handcrafting. It might be reasonable to recognise and develop these 2 skills more. So mainly creativity and collaboration and if I can add a third one, this is problem solving'* (teacher 1, non-formal pilot site).

> *The students had the chance to develop skills and although this was happening, they did not always realize it. We came across problem solving many times, but they did not realize it…For example, we had a technical problem, and we were trying to solve it, trying to find a solution for placing the led properly. All these things that are problem solving have not been consciously perceived as such, despite the fact that they are [...]"* (Teacher 2, formal pilot site)

Several reasons may have contributed to this however it is not easy to safely draw conclusions. The duration of the engagement with the tool, the nature of the maker activities/projects in the two pilot sites, the way the tool was introduced by the teachers, the way the students worked, the way the skills are defined in the tool, covid-19 challenges that resulted in breaks in the use of the tool, the complexity of different aspects of each skill, the different learning styles and reflective procedures, the tight formal education time framework may have all played a role towards the "reasonably" unequal grasping of the skills.

Connections to curricular skills and added value in curricular subjects

The participating teachers identified links between the Assessmake21 initiative and the objectives of the Greek school curriculum. As a matter of fact, the focus on 21st century skills development (engineered also through the Assessmake21 tool) was considered in line with the school curriculum goals. As far as the tool is concerned this was considered of added-value when used in makerspaces/fab-labs and STEM/STEAM related subjects, while the extended use of the tool in other subjects was also suggested. The following interview episodes from both formal and non-formal pilot sites reveals these thoughts.

> **Interview episode 1**
>
> **Interviewer:** *Do you think that the Assessmake21 initiative is in line with the objectives of the Greek school curriculum? Is there any connection?*

> *Teacher1:* I think so. If you go through the school curriculum and especially the courses related to informatics, technology, and the whole STEM package, you will notice that the skills (for sure the 5 skills that are covered through the tool) are mentioned there, so there is a connection[...]. The subjects of STEM / STEAM, for example, are structured around the acquisition of these skills [...]. I can say that there is and could be a connection between the curriculum and the tool. (Interview episode, Teacher 1, non-formal pilot site)

> *Interview episode 2*
>
> *Interviewer:* Is there any connection between the objectives described in the school curriculum and the Assessmake21 project initiative, as this is engineered through the tool?
>
> *Teacher2:* Definitely yes and especially in Greece, now that the course of Technology which I teach is reformed. Actually, next year the curriculum is going to change completely with a focus on STEM disciplines. So, it will be exactly this and the skills we are referring to will be there. I think that the tool will be relevant not only for use in fab-labs or makerspaces but in all the schools and curriculum subjects. (Interview episode, Teacher 2, formal pilot site)

The reinforcing/motivating role of badges

The teacher from the non-formal pilot site recognized that the badges gave students an extra motive to complete tasks advocating that "*badges is one of the advantages of the tool, as students are motivated to complete the challenges, and make more and more clicks".* This finding is in line with students' claims about the stimulating and motivating role of badges (Section 4.4.2). The teacher from the formal pilot site did not award badges to students, so there is not any feedback regarding this aspect from the formal pilot site.

Working with the tool: Challenges, Technical issues and Proposals

An issue raised by the teachers from both pilot sites was related to the need for a familiarization stage before the actual use of the tool by the students. This stage was considered necessary; therefore, it was suggested that adequate time should be spent on smoothly introducing the tool and ensuring that all the students are aware of what they are supposed to do (for more information on how the familiarization stage was organized and carried out see section 3.5.2). The lack of the skills definition menu in the Educator's dashboard was also highlighted as a weak point that, if available, could have contributed to better supporting students' understanding of the different aspects of the skills, ensuring that they are all *on the same page.*

➢ *"It would be easier for me, if I could see the definitions of the skills that were available to my students through their dashboard. In the familiarization stage, I introduced the skills and provided some explanations. If the definitions were available in my dashboard as well it would be very helpful to guide the students through the tool and the 5 skills".* (Teacher 2, formal pilot site)

In terms of the management of the classes in the Educator's dashboard, teachers found it a bit cumbersome that once they had created classes, they could not move students from one class to another. This need emerged especially in the non-formal pilot site where some students requested to change groups due to some conflicts with other extracurricular activities.

Teachers' comments on the interface of the tool were mainly positive. The interface was considered aesthetic and clear. However, they suggested that fewer and bigger buttons (in the students' interface) could further improve students' experience.

Regarding the 3rd approach as well, it was seen as frustrating that it was not clear from the beginning when a challenge session ends. This issue was also brought up by students.

> *"[...]it should be clearer when a section begins and when it ends, so that the students get an idea of how many challenges are left to complete at each stage" (Teacher 2, formal pilot site).*

Another confusing aspect (which had been also raised by the students) was the use of the 0-4 rating scale, with the teacher from the formal pilot site recommending the replacement with a scale that gives more options, looks more familiar to students, and provides a clear neutral point.

Language issues were also mentioned, with the teachers suggesting an easier to grasp language in both the Greek and the English interface. The Greek interface seemed to cause frustration to the teachers in the beginning, with the one pilot site to wait for updates and improvements and the other to work directly in the English version.

In addition, there was a suggestion to feed the students' interface with more information regarding students' progress, through graphs and charts, similar to what is available in the Educator's dashboard.

Regarding question types, the teachers recognised the pedagogical value of open-ended questions as they could help them get an insight into students' thoughts, reasoning and understanding. The picture taking challenges, although it was considered a good reflective practice, seemed to be cumbersome and time consuming for those working on PCs. The challenge was even bigger for the teacher from the formal pilot site who had to deal with very tight time constraints. Last, the teachers identified the lack of "elements of surprise" (such as additional types of challenges that move beyond the classic pattern of answering questions) in the set of challenges. The existing questions/challenges were considered very predictable.

> *"The questions soon became predictable. It should not be that easy to predict what comes next, this way you would keep students alert and make them want to use the tool more and more". (Teacher 1, non-formal pilot site)*

4.4.4 Lessons Learned

In summary, students and teachers seem to have had a positive experience using the Assessmake21 tool, acknowledging its value in the development and understanding of 21st century skills. Most of the students, in both formal and non-formal pilot sites, seem to have had a positive experience recognizing the role of the Assessmake21 tool towards setting goals, progress monitoring and 21st century skills development and awareness, as well as acknowledging the skill transferability in other contexts and subject areas. They highlighted aesthetic aspects of the tool expressing positive comments on the overall design, while the

students from the non-formal site considered the award of badges as a stimulating mechanism towards using the tool further and exploring its potential deeper.

Teachers from both pilot sites expressed their satisfaction with the use of the tool and seem to acknowledge the role of the Assessmake21 tool in relation to 21st century skills development and awareness. Both teachers recognized connections to the curriculum in the Greek context in several subjects, and suggested that the tool could be of added value in STEM/STEAM courses and beyond. The teacher from the non-formal pilot site who allocated badges recognized their stimulating and motivating role.

Weak aspects, bugs and technical issues that challenged the two pilot sites were also reported together with some recommendations and proposals from the participating students and teachers. Although there are lots of similarities in the feedback retrieved from the two pilot sites, it is worth mentioning that the use of the tool in formal education was considered as an extra workload for the teacher (where the timeframe is really tight), with the teacher highlighting tensions between school program and the creative use of the tool within school subjects.

The way the tool is used, the equipment that is used or is available, the duration of students' engagement with the tool, the different learning styles and reflective procedures, the tight time framework in formal education, Covid-19 challenges and technical problems, all seem to affect the users' experiences. Nevertheless, the Assessmake21 pilots invited participants to dive into a new process, to explore and use a new tool, to reflect upon the way they learn and develop skills. No matter the difficulties and the challenges, the participating teachers and students took up the challenge and through their feedback showed us the way to further support their educational and reflective journey.

4.5 The Ireland Experience

4.5.1 Summary of Experience

The key highlights of the student and teacher experience with the Assessmake21 tool during the Irish pilot are shown in Table 9.

Table 9: Irish Pilot highlights

Student Experience	
Pros	**Cons and Challenges**
Student Experiences ➢ Overall, a positive experience ➢ Good engagement from students ➢ Students have used the tool to reflect on their skills and the teacher has definitely noticed an improved engagement around and awareness of 21C skills among students ➢ Tool generally easy to use and navigate	➢ Challenges around uploading photos because of using desktops ➢ Some challenges confusing or tedious to students, self-assessment component ➢ Repetitive boring challenges ➢ Some students did not really grasp the concept or relevance of 21C ➢ Students did not like having to finger type challenges in (use of iPad) ➢ Time consuming
Teacher Experience	
Pros	**Cons and Challenges**
➢ Felt that the very nature of the tool and the project at least started the conversation about skills development and reflection 'there is a lot of scope for further improvement and benefits of this tool' ➢ Tool helped students consider their understanding and their attitude to 21C skills	➢ Teacher did not use dashboard frequently and did not see how it fit into their workflow ➢ Did not have the time to consult teacher dashboard, too busy ➢ While good engagement at start, teacher felt that students quickly forgot about the tool and did not manage to build the tagging process into their sessions (a mixture of forgetting, not having time or not wanting to use the tool) ➢ "Students still find it tricky to use and don't really care to use it (they will cooperatively use it when ordered to" (Maker facilitator)
Overall Summary	

- In one pilot classroom (Group 1), students and teachers had good experience and engagement with the Assessmake21 tool.
- In the other pilot classroom (Group 2), the students found that the tool was not easy to work into their workflow, and found the challenges boring and time consuming
- Overall, the act of reflection on 21C was viewed positively by teachers and some students, however the fact that students had to answer challenges and enter reflections on the fly did always fit the context of the makerspace activities (time consuming, sometimes repetitive, distracting)

The key aspects of the pilot activities in Ireland are described below.

Different Experiences between Group 1 and Group 2

In the two groups formally tracked in Ireland (See Section 3.5.3 for details of Groups), there was sharp difference in experience between the two groups. This is best illustrated in Figure 36, which shows the responses to the post-survey question related to the user experience of the Assessmake21 tool. This figure shows a clearly more positive experience for Group 1 over Group 2. The qualitative aspects of this finding are explained in more detail in Section 4.5.2.
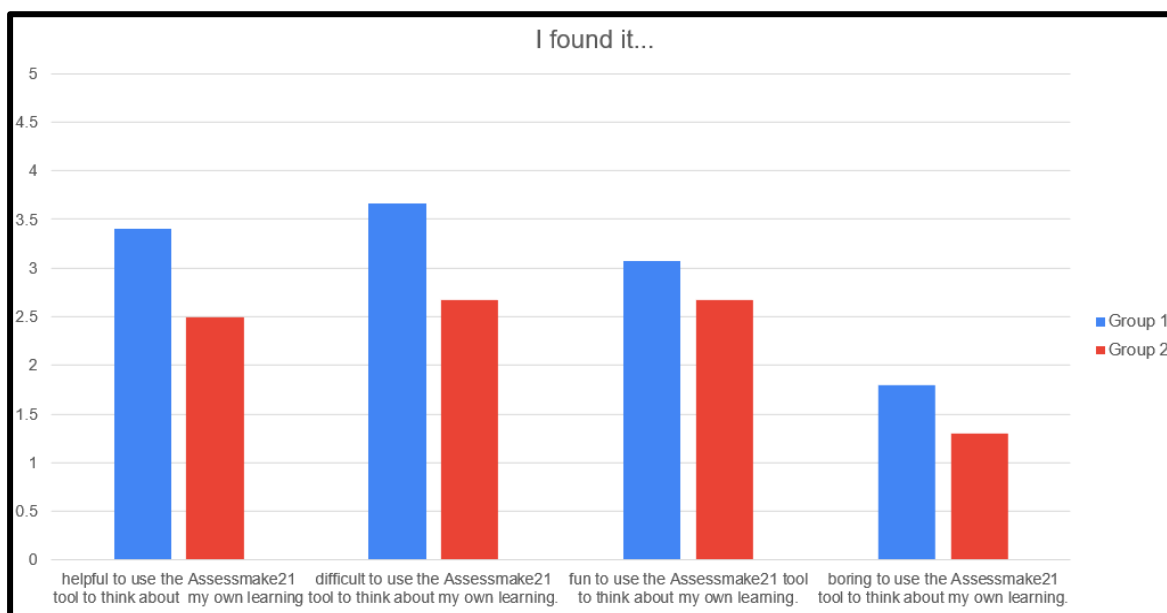
Figure 36: Different experiences for two groups tracked in Ireland

Training

Teachers considered the training to be effective but excessive. They found the PDF and PPT guides very useful.

- *I thought the three days training was excessive. I think the whole thing could have been two hours. For me three days was too long, I was bored. I know it was important for different partners to introduce themselves and talk about the purpose of the project and their research but it was too much of an ask for us.*

> *The PDFs were very handy. I put the PDF with the student guidance on their google classroom. So, they could go back themselves and check if they were stuck. I tried to push them to solve their own problems with the app using the documentation provided.*

Self-managing students

While student largely self-managed and solved their own problems, they still need reminding to use the tool.

> *A lot of the student could self-manage, but I would still remind them, it would be a like a general comment to the whole class like 'are you tagging?'. I didn't try to single any students out, I just kind of did general prompts and reminders. They were always reminded at the start of class to have their tabs open. I did leave them to themselves a lot of the time but maybe if there were 5 minutes left in the class, I would give a final reminder.*

> *So, I demoed the tool on day 1, so they got a sense of how to use it and why they had to use it. They'd seen me using it so they realized that it was accessible and usable. I'd say a lot of the problems they encountered, for example to do with wording of challenges, they leaned on each other as a group rather than on me. They would be asking each other 'what do you think this question means' etc. They problem solved themselves*

Device Use

> Like in other pilot countries, there were different experiences according to the devices students used, with pros and cons recorded for each. For example, the tablet was better for uploading photos but the relatively large amount of touch typing required was not welcomed by students. While the desktop computers used by group 1 were better suited to typing, it made photo upload more difficult. Therefore, students in Group 1 did not like getting photo related challenges.

Educators App

Teachers engaged very little with the educator app, seeing the makerspaces as something organic that didn't require monitoring.

> *No, I didn't use it much, there was too much other stuff going on in the classroom. My only concern was to see them using it really. It is something I glanced at time to time to see what skills tags were accumulating, but really, I just wanted to see that they were using the tool responsibly and therefore thinking about what skills they were using. The whole point of these makerspaces is that they are mostly student led. So, there is no prescription. I review the teacher dashboard from the point of view of interest, but I am not going to intervene if I see what a certain skill is being tagged enough or that a certain student isn't tagging enough. I want it to be more organic. I'll use the data from tool to write their end of year reports. t say they used this tool to help them identify and develop certain skills.*

4.5.2 Student Experience

The qualitative perspectives of the students in each group shows a divided experience of the Assessmake21 tool. Figure 37 shows the key sentiments captured from each group during the student focus groups, with more detailed examination below.

Figure 37: Experiences of Irish students

The comments from both groups are outlined below. When we examine the negative comments from both groups, we some alignment around the key challenges of the Assessmake21 tool for students.

Group 1 Positive Comments

> *It was easy to use, it was clear about what to do. It was very clear what you needed to click on or what you needed to do to proceed.*
> *I think it added to the learning. It added structure to the learning by guiding you through some questions.*
> *The app was just easy to use, the buttons were big and clear.*
> *We would like to use this again because it lets you actually see what you are learning from doing something, and not just doing it for the sake of it. It lets you see what you're doing and think about what skills you are using.*
> *It's good the way it lets you see what level you are at, and you can rate how well you use the skill. You can keep track of what you've done.*
> *I think I'd be more aware of these skills in other activities now*
> *It might be good for younger students to just to get them to start thinking about these skills. Maybe it would be good to start as soon as they come into the school. I think it's important to reflect on what*

you're doing because in a lot of classes the teacher says 'oh you have to reflect', so I think this app has allowed us to practice reflecting, it will be useful for other subjects.

Group 1 Negative Comments

➢ *The photos were easy to upload but because we had desktops it wasn't always easy to get photos form our phones onto the desktop. It would be good if you didn't always have to upload a photo, that maybe you could just type some comments about what you were doing.*

➢ *It was a bit monotonous to have to go in and answer the questions upload stuff, but it was ok, it was easy to use but sometimes kind of boring.*

➢ *The login wasn't very easy, we always had to find our code. It would be better if you could just login with google since we are already logged into google on our machines.*

Group 1 Recommendations

➢ *It would be good to change the whole photo thing, for computers that don't have cameras it was sometimes difficult to get photos onto the computer to upload. Maybe we could use it on our phone, that would be better. This would save us having to transfer from phone to desktop*

Group 2 Positive Comments

➢ *The only good part was when we had to log off (sic)*

Group 2 Negative Comments

➢ *It was easy to use but it was such an effort. It was boring, the app didn't benefit us at all.*

➢ *It didn't feel like there was a purpose to using it and it felt like it was just wasting our time that we should be spending doing the activity. There has to be an easier way to record our activities, like writing them down!*

➢ *It was really just pointing out the obvious, we didn't understand why we needed to write it down.*

➢ *It was painful to have to upload photos*

➢ *The challenges did seem relevant and were very repetitive. They took a lot of time and in some classes, we did not have much time as we needed to actually make our stuff for the project.*

4.5.3 Teacher Experience

In Figure 38 the experiences of the facilitator in Group 1 are presented. These quotes represent the highlights of the interview conducted with the teacher once the pilot had ended.
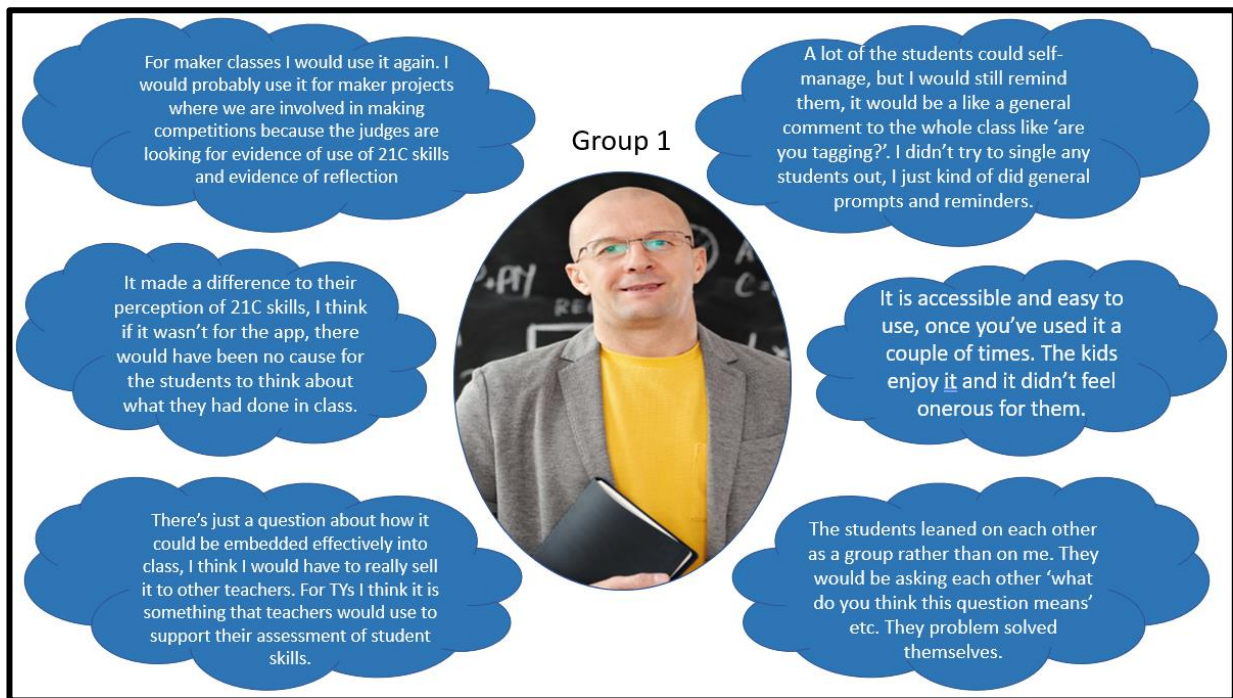

Figure 38: Positive Experience of Group 1

In Figure 39 the experiences of the group 2 facilitator are presented. This paints a somewhat different picture from Group 1, with more negative than positive experiences being reported.
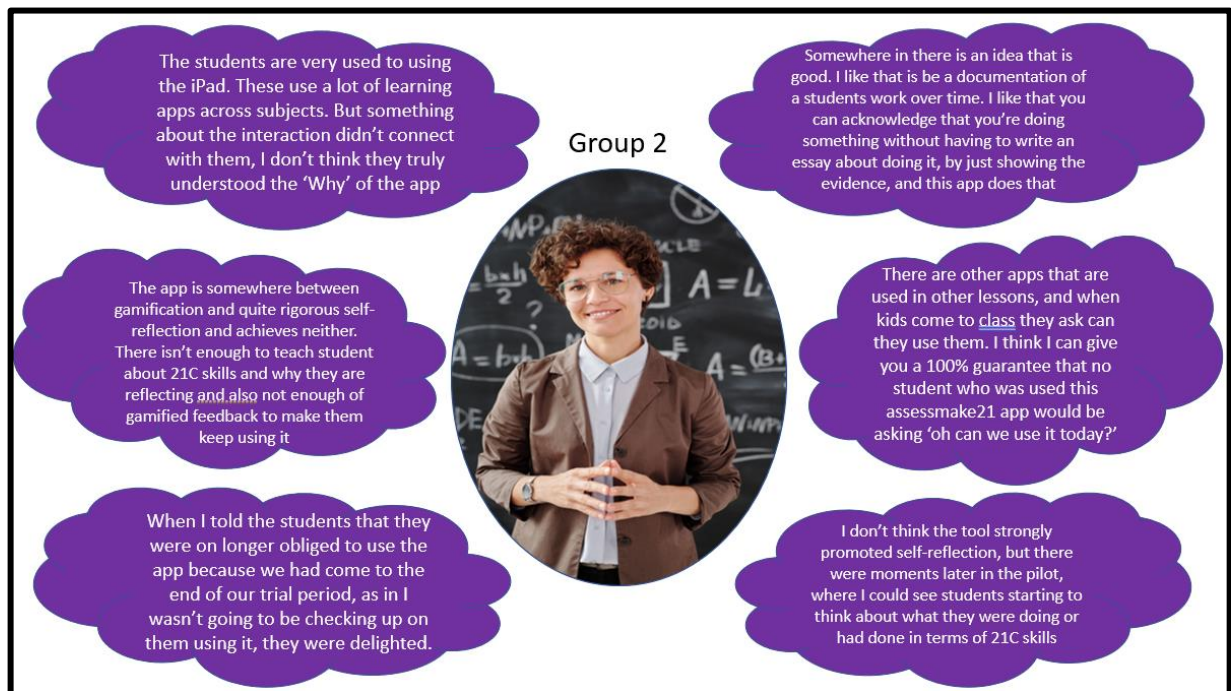

Figure 39: Negative Experience of Group 2

Expectation vs Reality

One of the teachers (Group 2) had high expectations for the App and really felt it was going to make a difference in her Makerspace. However, she explained why her expectations were not met.

> ➢ *I was hoping the ability to tag skills as they were using them would help them connect how they think about learning to what they are actually doing. Then I was also hoping that they could collect photographs as evidence of work they were doing, which would help build a kind of natural document portfolio of their work which would represent their various interests and through which they could reflect how into or not into the subject they are. At the moment, we heavily rely on teacher documented evidence of work which by its nature is generally a one size fits all and never really feels naturally integrated. These expectations were not really met. This surprised me. The students are very used to using the iPad. These use a lot of learning apps across subjects. So, I thought they would get it. But something about the interaction didn't connect with them and it's something around the idea of understanding the why they had to tap or record these skills. In a way it (the tool) didn't really reflect their work back to them in a way that made it seem like they were building a portfolio, somewhere where they could scroll down through all their work like a google site. But it also didn't reward them enough when they were tapping the screen.*

Usefulness

➢ *Somewhere in there is an idea that is really good, or maybe could be really good. I like that is be a documentation of a student's work overtime. I like that you can acknowledge that you're doing something without having to write an essay about doing it, by just showing the evidence. The concept is really positive.*

➢ *I think the app is somewhere between gamification and quite rigorous self-reflection and really achieves neither. So, there isn't enough to make the student understand the purpose of the reflection and why they are doing it, and also not enough gamified feedback to make them keep using it.*

➢ *I think if it wasn't for the app, there would have been no cause for the students to think about what they had done in class. So having that time at the end allocated to the use of the app, made them reflect whereas they wouldn't have done that without that app.*

➢ *The kids enjoy it and it didn't feel onerous for them. There's just a question about how it could be embedded effectively into class, I think I would have to really sell it to other teachers.*

Ease of Use

> ➢ *I think the tool was fairly intuitive. Like the students did understand how to interact with it, it wasn't like they were getting lost or anything*.

> ➢ *The app was not painful to use, it was not an outright failure, there was nobody having meltdowns, it just didn't quite work for us.*

> ➢ *Accessible and easy to use, once you've used it a couple of time.*

> ➢ *It was a little bit glitchy on the iPad, so sometimes when you tagged it was say logged but then it would stop, and the students didn't know if it had stopped or locked or if the log was successful. So, it was a little bit clunky which is understandable because it's in beta*

Likes

➢ *They liked the ease of tapping. It didn't feel onerous to them. They could tap as they went along.*

Misunderstanding and Miscomprehension

➢ *If you look at what they put into their dashboard, it looks like they only ever hit two of their skills, and I know for a fact that was not the case. I do understand they were the ones that they see most frequently. They didn't necessarily conceptualize the things they were doing as fitting more than one skill. A lot of the time they felt they didn't demonstrate enough evidence of one of the skills so would just tap Collaboration again. Maybe they didn't understand you could tag two skills for the same activity, or was this an option on the app?*

Difficulties

➢ *it was the Why aspect that really feel between two stools. I think the use just didn't give the students and teachers a meaningful picture of what was happening in the room.*

➢ *It was very hard on the teacher end to get more granular data on what was happening unless they had completed something. So, you'd go in and see that kid has completed two dots and had requested a badge, but I didn't know what the two dots were and when I awarded the badge nothing happened because I assume they hadn't done enough yet to be awarded the badge. But for some reason they had been able to request the badge*

➢ *I would describe the tool as useful but in the context of our school I would describe it as limiting. Because we are not a tablet school, we don't have access to devices to get the best use of this tool*

➢ *The app required me to do a lot of teaching to recognize what the skills were. The app wasn't actually teaching them to recognize the use of the skills. A lot of the time it would take the intervention of a facilitator to help the students recognize the skill or be aware of the skill, which kind of negates the purpose of the tool then*

Dislike

➢ *They hated when they had to upload pictures. I'd day it would work fine for iPads but on a desktop device it didn't work. When the picture question came up there was a noticeable frustration, a lot of them just uploaded pictures already saved on the desktop. The workflow of taking a picture on their phone and uploading it to drive was too much. They didn't have time to do this because they were answering the challenges at the end of the class. The students were always wishing it wouldn't be a picture question. This shifted focus away from the actual skill itself and dominated a lot of the interactions.*

Recommendations

➢ *I think I would use it again with minor tweaking and I think it would need to be a new class. I think the current students have become too frustrated with it to use it again. I think if I was to go again, I could control some of the issues with the app. I think in its current form I would probably build up the gamification for it. So maybe you need to get to 20 points to complete a level, and a photograph is worth three and you need to get 20 points by the end of the week, and there's a prize for most inventive photo etc. I could definitely integrate those requirements into my lesson plan, but I think*

they could also be built into the app (setting targets). In a way, I was happy to let it fail in this round because I wanted to see what it was on its own terms.

➢ *Maybe the app could provide more prompts to help the students, like a treasure hunt, 'get a picture of you helping somebody else, or solving a problem etc'. The app could do more to support the recognition of skills, but really it takes some training to recognize these skills. Like if this was a research operation you would need to train the research to recognize things they were observing and tick a box, so maybe it was too much to expect the students to be able to do this.*

➢ *I think having the ability to skip some questions the odd time would alleviate some of the frustrations the students felt, and would relieve the time burden they felt when they were rushing to get it done at the end of the class. This might give them a bit more autonomy*

4.5.4 Lessons Learned

The Assessmake21 met with mixed success in the Irish trials. Teachers saw the value of the tool in terms of raising awareness and understanding on 21C century skills. They did indeed observe that students were slowly becoming more conscious and curious about their use of 21C skills. As in other centres, there was difficulty for students to relate what they were doing to the definitions of skills in the tool and also difficulty in distinguishing clearly between the five skills. Clearly there some technical and user experience challenges with the tool, such as the problem of uploading pictures, the time it takes to complete challenges and the repetitive nature of challenges and questions.

It was clear that the tool required extensive onboarding, not only to understand the interactive nature of the tool, but also to understand how exactly the tool is worked into the workflow of the student in a makerspace, and when they should tag and skill and why. In general teachers had to frequently remind students of the need to tag and why it was important.

Based on the direct feedback from teachers and students, our conclusion is also that the students need some more contextual onboarding to truly understand the 'why' of the tool and not just the 'what'. They recognised that this is generally a new concept for students and that introduction of such will take some time. While many factors influenced the outcome of the pilot in Ireland, including different contexts of the makerspaces, age of the students, covid, and other time constraints, the tool did generally prove somewhat difficult to engage with, and both teachers recommended design and interactive changes before they would use it again.

4.6 The Sweden Experience

Since conditions from all classes are similar, we report the results jointly and not separate for each class.

4.6.1 Summary of Experience

The key highlights of the student and teacher experience with the Assessmake21 tool during the Swedish pilot are shown in Table 10.

Table 10: Swedish Pilots Highlights

Student Experience	
Pros	**Cons and Challenges**
Supported understanding of 21C skills to some extent	➢ Technical issues (too many clicks, difficult to use phone, difficult to upload pictures, if checking definitions of skills thrown back to start). ➢ Complicated language. ➢ Too many similar questions. ➢ Definitions of skills are complicated and some skills very similar.
Teacher Experience	
Pros	**Cons and Challenges**
Supported understanding of 21C skill to some extent	➢ Technical issues (too many clicks, difficult to use phone, difficult to upload pictures, if checking definitions of skills thrown back to start). ➢ Complicated language. ➢ Definitions of skills are complicated and some skills very similar. ➢ Time consuming. ➢ Students need a lot of support with the tool. ➢ Needed to add materials to show definitions of the skills. ➢ Other tools for assessment are better for teachers.

The key aspects of the pilot activities in Sweden are described below.

Onboarding

➢ All of the four teachers presented the Assessmake21 tool to their classes before starting with any maker project. The students worked with the tool in the PCs or Chromebooks. The students were provided with credentials from the teachers to be able to log in to the tool.

Utilising different approaches

- Teachers adopted the approach to suit their classrooms. One of the teachers participated with three classes and she chose to try all three approaches, one with each class, to compare herself which approach seemed to work best. She deemed the 3rd approach (at the end) to be best so that students could concentrate on one thing at a time.

Use of Educator App

- None of the teachers said that they had used the Educator dashboard to any large extent except for adding the students and creating projects. One of the teachers argued that she was frustrated that she needed to create new projects every time they did something new. She just wanted to create her class and not separate every project.

Difficulty with Photo Upload

- The students took pictures with their own smartphones and then they needed to upload these to their PCs or Chromebooks, a process that for the students were frustrating, taking extra time.

Overcoming Confusion about Skill Definitions

- One of the teachers noticed quite early that her students had problems when using the Assessmake21 tool and searching for the definitions of the 21st century skills when they were working with challenges in the tool. Therefore, she created posters with the definitions of the skills as well as leaflets for the students to have at their desks.

4.6.2 Students' Experience

Positive comments from Students

The positive comments from students in Sweden only covered the fact that the Assessmake21 tool made the students aware of the 21st century skills. However, this is of course a positive effect from using the tool. Students also realized that 21st century skills can be developed both in different school subjects and in activities out-of-school.

- *It was good [the Assessmake 21 tool] because you became aware of for instance if you thought that you were creative during the activity [maker activity] and you felt that you wanted to improve yourself the next time.*

- *It made me reflect. Like for instance about collaboration. How much do I collaborate with others? You may realise that you are not very good at that, collaboration I mean. Collaboration is important, like in the future, when you have a job, you have to collaborate with others.*

- *Well, you can develop these skills [21st century skills] in many subjects in school, in design and technology for sure, in arts and in all subjects, you can work together with others and develop collaboration.*

- *I collaborate with others when I play football, so, it doesn't need to be in school.*

Negative comments from Students

The Swedish students were mainly presenting critical comments about the Assessmake21 tool, it was about technical aspects, like needing to click several times, repetitive and too many questions, problems with uploading pictures etcetera. Here are some examples of how the students commented:

➢ *You needed to click so many times before you moved forward in the app, that was frustrating and made me lose interest. It was simply boring.*

➢ *It was annoying to respond to all the questions in the app. It took me about 30 minutes to respond to questions before I received a badge.*

➢ *It was complicated to upload a picture in the app, because we take pictures with our phones and then we needed to somehow get it into the laptop and then we needed to send the picture from the phone to our web platform (Teams classroom) and then take it from there to the app. It took such a long time.*

➢ *There were so many words in the app, explaining the skills and when you were working you forgot the meaning of the skills and needed to go back in the app, but then you had to start all over again. So, our teacher made posters and put them on the walls in the classrooms so we could look at these instead to find explanations of the skills.*

➢ *It was difficult to understand everything in the app, there were many difficult words. We have used it four-five times and I don't understand the meaning of the app. (grade 7 students comment).*

➢ *I don't understand the meaning of social/life skills despite the explanations. Isn't it the same as collaboration, and or communication? If you are good at that you must be a social person?*

4.6.3 Teacher Experience

Positive Comments from the Teachers

The teachers in Sweden had similar comments as the students and the positive outcome of using the Assessmake21 tool from their point of view related to the same thing as the students emphasized, namely that students became aware of the skills and that this was something new for their students.

➢ *The app was good because it made many students aware of the skills and they talked about how useful some of the skills would be for them in the future.*

➢ *The positive thing about the app was that students started to think about the skills, this was something they never had reflected on before.*

Negative comments from Teachers

Like the students, the teachers had more critical comments about the Assessmake21 tool. The teachers emphasized that the students needed a lot of support working with the tool. They also noticed that students had problems with the explanations of the skills, the language in the tool and technical problems, like the uploading of pictures being complicated using Chromebooks or PCs. Here are some examples of how the teachers commented on the experience of using the Assessmake21 tool:

➢ *Many students needed a lot of support in how to use the app. It was not that self-instructing. At least not for my students.*

➤ *The language was too complicated for my students. The explanations of the skills were also very long. I made sheets with the explanations and handed them out to the students so they had them on the side as a complement when they were working with the self-assessment. I also talked about all of the skills and tried to give the students examples. When the students wanted to check the definitions in the app while they were responding to questions they were thrown back to the beginning. I simply needed to find a solution to this problem, that's why I made the sheets with the definitions.*

➤ *I am sorry, but I was not that impressed by the app. Too complicated, for instance, the students needed to make so many clicks to move forward, the language was often long and complicated not to mention how time consuming it was and the students rather wanted to spend their time on the maker activities.*

➤ *As a teacher we already have several tools for assessment, so for us the tool is not interesting. I cannot work with yet another one.*

4.6.4 Lessons Learned

Students and teachers agreed that the best experience of using the Assessmake21 tool was that students became aware of 21st century skills and this was something they appreciated.

However, both students and teachers argued that the definitions of the skills were not that easy and the differences between the skills are not always clear. This is also reflected in the data from the post-questionnaire with the students that show hardly any differences between how students have graded their understanding of the skills.

Technical issues such as the problem of uploading pictures, the need to click many times before being able to move forward in the tool were mentioned by both students and teachers.

There were also comments about the language in the Assessmake21 tool and students and teachers were of the same opinion. There were too long explanations of the skills and complicated language and that there were too many questions to respond to in the tool. In addition, the students argued that the questions often were the same, or similar, and this was something they found annoying.

The teachers added that students needed a lot of support using the tool. Our conclusion is also that the students were not used to this kind of tool or to do self-assessment. There were probably many factors that may have influenced the outcome. However, as already mentioned, even though thinking, and reflecting about the skills was something new for the students, this was something they appreciated.

5 Reflections on the results

In this section we summarise and reflect on the findings from the four countries where the pilots testing the Assessmake21 tool took place. What kind of picture appears when we put the pieces together? What kind of similarities and/or differences can we identify? We return to the original main questions from this project and start to reflect in the outcomes of how the tool was used by teachers and students.

5.1 The Usage Picture

Session Duration and Approach

From the *teacher perspective* we notice that they chose either short or medium duration of the Assessmake21 tool. (Duration is about how many challenges students need to do in the tool). When it comes to the choice of approach, all three possible approaches were tested. However, the 'At the End' (3rd) approach was the most frequently used. Still, there were teachers (from Cyprus) who found it problematic to use this approach, since it led to a large accumulation of challenges for students to complete in one sitting, leading to tedium and frustration for students. Teachers from all countries presented pros and cons with all approaches and the overall picture is that it is possible to choose whatever approach that is suitable in different contexts, which also was the idea with the tool (see https://www.assessmake21.eu/io1/).

Teacher Dashboard

The teachers had a dashboard to use where they could follow their students' progress and provided them with badges. However, few teachers actually used the dashboard to any larger extent. We find that there may be several explanations to this. One of them being that the Assessmake21 tool was new to all of them and their focus was on how to support their students. Teachers from Sweden argued that they already had so many assessments tools in school [however, not on 21st century skills] and that they did not have an interest in adding even another tool. On the other hand, in Cyprus teachers expressed that they had used the dashboard and found it positive and useful. This was found both in non-formal and formal settings.

Device Preference

An idea with the Assessmake21 https://www.assessmake21.eu/io1/ was that it should work with any kind of digital device, such as PCs, Chromebooks, tablets and mobile phones. In our pilots all kinds of devices were used. However, from the pilots we find that tablets (e.g. iPads) were arguably the most suitable, since this was the easiest way to capture and upload images to the Assessmake21 tool. However, the tablet also had shortcomings. For example, students found it problematic to shift between different tabs on internet, shifting from the website for the Assessmake21 tool and other sites, like when searching for information etcetera. Students also found it difficult to type large amounts of text using the tablets. In Ireland we saw a better experience with desktop computers than iPads, perhaps because students didn't like having to finger type long answers into text boxes at the challenges. This was despite the challenge in uploading images to the desktop. Perhaps the best way to handle this was to use a combination of devices. The problem for students to shift between different tabs on internet is also something that earlier has been reported from research

(Enochsson, 2018; Walan, 2020.). These are workflow issues that could be overcome through training, increased technology, or device experience, or by splitting tasks between students in a group.

Skill Tagging

From the *student perspective* we notice that collaboration was the most often tagged skill in all four countries. This was followed by creativity as the second tagged skill. We believe, also based on comments from teachers, that the reason for this was the order of how the skills appeared in the tool and that students "started from the beginning". Hence, an explanation could be that they did not have time to go through all five skills. Another explanation could be that students were more unsure about the definition of some of the skills, in particular life/social skills (which also was confirmed by teachers and students in interviews) and therefore did not tag this skill to any larger extent.

Pilot Duration

We notice that in Sweden and Ireland the Assessmake21 tool was used intensive during a shorter period (about two months), while in Cyprus and Greece the use lasted during a longer period of up to five months. In Cyprus and Greece, the tool was used both in non-formal and formal makerspace settings. In Sweden and Ireland, the tool was used only in formal settings.

5.2 The Experience Picture

Here, we naturally move on to the discussion and reflections on how students and teachers experienced the use of the tool. The common picture for all countries also shows quite similar findings. As In all countries the experiences of students and teachers were quite similar no matter if they had tried the Assessmake21 tool in non-formal or formal settings.

Increased Awareness of 21st Century Skills

There were no quantitatively measured differences found in students' understanding of the 21st century skills. Still, in all countries students argued (qualitatively) that they became more aware of the skills thanks to the use of the Assessmake21 tool. This was also confirmed by the teachers.

Terminology and Language

In terms of challenges the overall picture is also similar across all countries and contexts. There were challenges with uploading of pictures depending on the kind of device that was used as already mentioned. There were also comments from both students and teachers that even though questions were easy to understand, the language in the tool was perceived as difficult and that were too many words [mainly in explanations of the skills], therefore making it difficult to understand the definitions of some skills. This kind of language issue was similarly reported in the precursor of the Assessmake21 project, the *Skilltrack* App (Kipp, Kapros & O-Keeffe, 2018).

From this, we can conclude that it is difficult to find a language that is easy for students to understand in this context. However, it is also possible that this has to do with the age of the students using the tool. For example, in Ireland we see better qualitative experience from older students than a similar cohort of younger

students. They seemed to take it more seriously and better understand the concept and relevance of 21C to their learning and development. The difference in tone and attitude between the two student focus groups is stark (see section 4.5.2). The language issue was also possibly compounded by the difficulty in translating complex statements and explanations into other languages (in this case Greek and Swedish), and the technical language that may not have translated appropriately for students who may have been new to such language regarding 21st century skills.

Time Burden and Onboarding

In all countries it was also reported that it was time consuming to use the tool. We have an explicit reason for this as captured from qualitative student experiences, namely that there were simply too many challenges (questions) to answer. This could of course be solved in an update of the Assessmake21 tool, by introducing shorter or more streamlined challenges (max 2 challenges per day for example). From Cyprus and Greece, it was reported that students felt that working with the Assessmake21 tool took valuable time away from the making activities. Even though this was not mentioned in the data from Sweden and Ireland we believe that students in these countries as well find making more fun and also that self-assessing/reflecting maybe is not the most inspiring thing for students to do. Implicitly, we could conclude that the introduction of a new tool that is attempting to teach a new concept to students, one that calls for the introduction of new language and terms, may have required a more substantial period of onboarding for students, and a more simplified instructional approach. This is certainly a lesson learned from this project, and onboarding material and instructional design may need to be enhanced in future similar projects.

Support of Facilitators

Another common finding reported from the four countries was that the educators played an important role supporting students in how to use the Assessmake21 tool. Indeed, educators' role is of great importance, and this has been emphasised in several research studies when it comes to learning, so this was not really a surprise. In all countries, teachers reported that students needed a lot of support with the tool, also not surprising. Encountering a new concept or subject matter requires time to learn and understand. Teachers were innovative and found their own solutions for instance how to support students' understanding of the 21st century skills. This was particularly reported from Greece and Sweden. It was reported in Ireland that teachers made use of quick start guides and other training material that were provided to them, however they usually just tried to teach the students the use of the tool 'as they went'.

Formal vs Non-Formal Settings for Makerspaces

Finally, we notice that within the formal setting in Greece, it was emphasised that there are tensions between school contexts and use of the Assessmake21 tool. It is possible that this also was the reason why the teachers from the schools in Sweden were not that enthusiastic about using the tool and why teachers in Ireland were also more aware of the time burden associated with the use of the tool due to timetabled schedules. This is a key challenge, as it is important that we are able to integrate maker activities and development of 21st century skills in schools, not only in non-formal settings, but also in formal school settings. Since there is international interest in integrating makerspaces and the maker culture in schools (Vourikari et al., 2019), the practical challenges of doing so need to be considered. In school, assessment is a natural part of education and therefore this project served as a way forward, trying to find how the digital self-assessment tool

Assessmake21 could be used to enhance assessment. However, as earlier reported by for instance Walan (2020), there are barriers to cross when implementing makerspaces and the maker culture in school, not only when it comes to assessment, but also to teachers' attitudes, access to resources and management of time schedules.

6 Conclusions

The main conclusions we make from testing the Assessmake21 tool in four countries and in non-formal and formal education settings is that:

- ➢ Students and teachers from all countries had common experiences from using the tool
- ➢ The tool served as an eye-opener for students about 21st century skills and how these can be developed during making activities, but also in different school subjects and in activities out-of-school
- ➢ Most students appreciated the possibility to self-assess
- ➢ There are challenges in the tool itself that need to be changed and improved such as the language, the explanation of some skills and number of challenges
- ➢ Students need support in how to use the tool
- ➢ There are some indications that it was more positive in general to use the tool in non-formal settings, more barriers to overcome in formal education settings

The development of the Assessmake21 tool is presented in the IO1 report https://www.assessmake21.eu/io1/. In that report it is described how the tool was developed through a design-based process, which is also typical for makerspace projects. Since this report presents the results of the pilot tests of the tool, they are indeed pilots and as such, the outcomes can lead to further improvements of the Assessmake21 tool to make even more appreciated. Hence, all this is also part of a design-based process.

6.1 Limitations

- ➢ Covid, not just absenteeism, but also the way remote and hybrid learning affected the social skills of students and changed students' perceptions and attitudes to group collaboration and social skills
- ➢ The mechanics of informed consent from parents were originally marked as potential roadblock in this project, however the forced migration to electronic consents due to Covid actually streamlined the process somewhat and led to better conversion rates in some countries. However, like with many projects involving the need for consents, it provided difficult to get consent for all students involved in the project, and therefore we had to exclude useful data from students who had no parental consent from our final results.
- ➢ The different contexts of the makerspaces made the comparison of experiences between countries and even different groups within countries difficult. We felt it was important to report on each countries individual experiences before bringing the conclusions together. Qualitative data provided more valuable that quantitative data in this sense
- ➢ Similar to the point above, varying approaches of facilitation by teachers make comparison hard, but that is why qualitative experience is so valuable compared to quantitative

6.2 Recommendations for Future studies/projects

Teacher Onboarding

First all of, the recommendations we want to make to future users of the Assessmake21 tool is that we believe that the best way to become acquainted with the tool is to attend some face-to face training if that is possible. However, where that is not possible or where resources do not allow for such targeted training, there will be user guides as well as videos available for those who wish to self-onboard. Having guides and instructions through videos that are accessible at any time we think will be appreciated by future users.

Device Suitability

Another recommendation for future users is to really consider what kind of device, approach and duration of the tool you think will be the most appropriate in your unique context. We observed mixed experiences with many kinds of devices in this project, and therefore cannot make any firm conclusions about the best device, however it is clear that different devices might suit different contexts, and that any future versions of the Assessmake21 tool should require less typing to be more suitable for touchscreen devices.

Student Onboarding

We also emphasise that students may need a lot of support when the tool is new to them, so teachers need to be aware of this, that it takes time to learn new things, in this case, to use a new digital self-assessment tool, Assessmake21. The burden for this should not solely fall on teachers however, the tool itself should be able to effectively onboard students and guide them through the learning, by providing relevant examples, simplifying workflows, using robust instructional design and making ore use of gamified elements.

Duration of Tasks

Across all pilot countries, regardless of overall experience of the students, we observed that students felt the time burden of completing the challenges was too great, and in some cases detracted from the time they wanted to spend on their makerspace work. As mentioned in the discussion, future iterations of the tool may need to focus on shorter or more streamlined challenges (max 2 challenges per day for example), and introduce a gamified elements to increase the payoff for students when completing tasks.

The Success of an almost entirely Remote Project!

Unrelated to the tool itself, we also learned valuable skills in running and collaborating on a remote international project. For future projects we also believe that despite all the good things with working digitally, not needing to travel etc, face-to-face meetings are of importance, and can lead to experiences that contribute to development of projects, that are not as easy to emulate when only working digital/online. The conditions for this project were special with the Covid-19 restrictions that made it impossible for us to have physical meetings. Despite the fact that we needed to work on this project totally online, we find that we did succeed! We successfully rolled out the tool for use in four countries with hundreds of students. We know that if we (hopefully not) end up with facing a new pandemic situation and restrictions, it is possible to run an Erasmus plus project successfully and with full positive outcomes.

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8 Appendix I

8.1 Instrument A: Data to be collected from Assessmake21 tool

Data from the Assessmake 21 tool is supposed to respond to the questions: How is the tool used by a) students and b) teachers). Data can also to some extent respond to the question: How are students experiences of the tool - based on their self-ratings using the tool.

STUDENT log

1. *Basic information about student activity.*
    How many students have used the tool in total/per country/school/class/group?
    What is the usage over time per country/school/class/group?
    What is the number of sessions (logins) per country/school/class/group/student?
    What is the number of actions (tag, challenge, examples) per session?

2. *Tagging.*

    To what extent have the students tagged different skills?

3. *Challenges.*

    To what extent have students fulfilled different challenges/tasks?

4. *Uploaded examples of student work.*

    To what extent have examples (pictures of students' work) been uploaded? (could be a problem, could depend on what kind of devices they use).

    Which skills have been associated with uploaded examples?

    What are students' self-rating of their own examples?

    Are there students who upload examples outside of progression through the levels? If so, how many?

TEACHER LOG

1. *Basic information about teacher activity.*

    How many teachers have used the tool in total/per country?

    What mode do teachers use with their classes?

    What duration do teachers use with their classes?

2. *Information related to assessment.*

    How many badges have the teachers delivered to the students based on what kind of activity?

    Do teachers view the analytics/visualisations of their class(es)?

8.2 Instrument B: Student Pre-questionnaire

Please answer the following questions regarding your experience of making/makerspace activities, different skills and experience of using the Assessmake21 tool to evaluate/self-assess your own learning. The scale ranges from 1 (strongly disagree) to 5 (strongly agree).

Statement	1	2	3	4	5
A. Makerspace activities					
A1. I have tried maker/makerspace activities.	☐	☐	☐	☐	☐
A2. I have tried maker/makerspace activities in school.	☐	☐	☐	☐	☐
A3. I have tried maker/makerspace activities at a makerspace.	☐	☐	☐	☐	☐
B. Different skills - Collaboration					
B1. Those who are good at collaboration find it easy to learn together with others.	☐	☐	☐	☐	☐
B2. Those who are good at collaboration contribute when working in groups.	☐	☐	☐	☐	☐
B3. Those who are good at collaboration are flexible and can compromise.	☐	☐	☐	☐	☐
B4. I have an idea of what is meant by collaboration.	☐	☐	☐	☐	☐
C. Different skills - Creativity					
C1. Those who are creative find it easy to have new ideas and develop them in practice.	☐	☐	☐	☐	☐
C2. Those who are creative can show originality in their work when they create something.	☐	☐	☐	☐	☐
C3. Those who are creative view failure as an opportunity learn.	☐	☐	☐	☐	☐
C4. I have an idea of what is meant by being creative.	☐	☐	☐	☐	☐
D. Different skills – Problem-solving					

D1.Those who are good at problem-solving can find many ways to solve a problem.	☐	☐	☐	☐	☐
D2. Those who are good at problem-solving can create new products or services to solve problems/needs.	☐	☐	☐	☐	☐
D3. Those who are good at problem-solving can use different techniques to find solutions.	☐	☐	☐	☐	☐
D4. I have an idea of what is meant by being a problem-solver.	☐	☐	☐	☐	☐
E. Different skills – Social skills					
E1. Those who have good social skills are determined to turn ideas into action/make things happen.	☐	☐	☐	☐	☐
E2. Those who have good social skills can inspire others to reach their very best.	☐	☐	☐	☐	☐
E3. Those who have good social skills are good at balancing different views to find solutions.	☐	☐	☐	☐	☐
E4. I have an idea of what is meant by having social skills.	☐	☐	☐	☐	☐
F. Different skills - Communication					
F1. Those who are good at communication can tell others about their ideas in many different ways, not only by talking.	☐	☐	☐	☐	☐
F2. Those who are good at communication can listen to others and hear what they really are saying.	☐	☐	☐	☐	☐
F3. Those who are good at communication can inspire and enthuse others.					
F4. I have an idea of what is meant by having communication skills.	☐	☐	☐	☐	☐
G. Evaluate/assess own learning					
G1. I have often evaluated/self-assessed my own learning.	☐	☐	☐	☐	☐
G2. I have tested tools like ePortfolio to evaluate/self-assess my own learning.	☐	☐	☐	☐	☐

G3. I have evaluated/self-assessed my own learning using other tools/methods than ePorfolio.	☐	☐	☐	☐	☐

8.3 Instrument C: Focus group interviews with students

This instrument will be used to respond to first of all RQ2 about students' user experiences of the Assessmake21 tool and their developed understanding of the 21C skills. The instrument can also contribute to responses to RQ1 about students' usage patterns.

Introduction questions

1. What kind of maker activities have you been involved in?
2. Where did these maker activities take place?
3. During/after these activities, you also tried the Assessmake 21 tool, what did you think about that?
4. Can you give me an example of how you have used Assessmake21 in your activities?

Practical experiences of using the Assessmake21 tool

Please tell me more about how you used the Assessmake21 tool.

How easy was it to use Assessmake21?

Did you experience any problems using the tool? Please describe.

Emotional experiences of using the Assessmake21 tool

➢ How did you feel about using the Assessmake21 tool? Fun? Boring?
➢ What did you like most while using the Assessmake21 tool?
➢ What did you like the least while using the Assessmake2 1tool?
➢ Would you like to continue using the Assessmake21 tool again in your next making projects Why/Why not?

Cognitive experiences – students' development of understanding 21C skills

➢ What kind of skills do you think you had the opportunity to practice/develop during the maker activities you participated in?
➢ In what way was it possible to practice/develop these skills?
➢ Did the Assessmake21 tool help you understand skills that you practiced/developed during the maker/makerspace activities? If yes, which ones?
➢ During your engagement in the making activities, to what extent do you think that you were:
  - solving a given problem?
  - collaborating with others to complete the given task?
  - making something creative?
  - got some training in how to communicate with others?
  - trained your social skills?
➢ Is it possible to practice/develop these kinds of skills in other kinds of activities in school and/or outside school? If so, what kind of activities and how?
➢ How would you describe the Assessmake21 tool to a friend? What is it about?

Final question

Do you have any other comments you would like to share about this experience of trying the Assessmake21 tool? Please tell us.

Thank you for your participation!

8.4 Instrument D: Semi-structured interviews with teachers

This instrument will be used to respond to RQ2, teachers' user experiences of the Assessmake21 tool and their developed knowledge of what kind of activities that can promote what 21C skills, as well as the alignment with curricular activities in the cases where this is possible. The interview also include questions that further can show how teachers used the tool (RQ1). The guide is based on a semi-structured interview approach.

Framing the setting

Facilitator/Teacher……………………………. (code for this person)

Date of Interview ………………………………

1. What was the number of students you worked with in this activity/project?
2. What is the age of the students?
3. Can you describe the classroom environment or setting where the activity (activities/project) took place?
4. What kind of makerspace activities were you involved in with your students?
5. What kind of approach did you use? Short, medium, long term for the activities?
6. How was your experience of participating in Assessmake21?

Expectations

1. What were your expectations when you started the pilots with makerspace activities and the use of Assessmake21?
2. Were these expectations met? Please explain how they were met, not met, or even excelled.

Practical experiences of using the Assessmake21 tool

1. How did you find it to use the Assessmake21 tool from a practical point of view?
2. How did you use the Assessmake21 tool? Please give us an example.
3. How effective would you say that the Assessmake21 tool is in documenting occurrence of 21C skills during makerspace activities? Please explain your answer.
4. What advantages do you see in using the Assessmake21 tool?
5. Have you observed any issues using the Assessmake21 tool? If so, what have you noticed?
6. Are there any improvements for the Assessmake21 tool that you would suggest? If so, which ones?

Emotional experiences of using the Assessmake21 tool

1. How did you feel about using the Assessmake21 tool?
2. What did you like most while using the Assessmake21 tool?
3. What did you like the least while using the Assessmake21tool?
4. Would you like to continue using the Assessmake21 tool again in your next making projects? Why/Why not?

Cognitive experiences – teachers' development of understanding 21C skills

1. What kind of skills did you identify that the students had the opportunity to develop during the activities that you have participated in?

2. In what way was it possible for them to develop these skills?
3. In what way, if any, do you think that the Assessmake21 tool was helpful for the students to develop their understanding of these skills?
4. In what way, if any, do you believe that the use of Assessmake21 promoted students' self-reflection?
5. Is it possible to develop these kinds of skills in other kinds of activities in school and/or outside school? If so, what kind of activities and how?
6. Could you identify any connections to curricular skills in this activity, if so, what kind of skills and what kind of required curricular skills?
7. How would you describe the Assessmake21 tool to a colleague? What is it about?

Final question

Do you have any other reflections you would like to share about this experience of trying the Assessmake21 tool? Please tell us.

Thank you for your participation

8.5 Instrument E: Student Post-questionnaire

Please answer the following questions regarding your experience of making/makerspace activities, different skills and experience of using the Assessmake21 tool to evaluate/self-assess your own learning. The scale ranges from 1 (strongly disagree) to 5 (strongly agree).

Statement	1	2	3	4	5
A. Makerspace activities					
A1. It was fun to do the maker/makerspace activities.	☐	☐	☐	☐	☐
A2. It was boring to do the maker/makerspace activities.	☐	☐	☐	☐	☐
A3. It was easy to do the maker/makerspace activities.	☐	☐	☐	☐	☐
A4. It was challenging to do the maker/makerspace activities.	☐	☐	☐	☐	☐
B. Different skills - Collaboration					
B1. Those who are good at collaboration find it easy to learn together with others.	☐	☐	☐	☐	☐
B2. Those who are good at collaboration contribute when working in groups.	☐	☐	☐	☐	☐
B3. Those who are good at collaboration are flexible and can compromise.	☐	☐	☐	☐	☐

B4. I have changed my mind of what I think is meant by collaboration after using the Assessmake21 tool.	☐	☐	☐	☐	☐
C. Different skills - Creativity					
C1. Those who are creative find it easy to come up with new ideas and develop them in practice.	☐	☐	☐	☐	☐
C2. Those who are creative can show originality in their work when they create something.	☐	☐	☐	☐	☐
C3. . Those who are creative view failure as an opportunity learn.	☐	☐	☐	☐	☐
C4. I have changed my mind of what I think is meant by being creative after using the Assessmake21 tool.	☐	☐	☐	☐	☐
D. Different skills – Problem-solving					
D1.Those who are good at problem-solving can find many ways to solve a problem.	☐	☐	☐	☐	☐
D2. Those who are good at problem-solving can create new products or services to solve problems/needs.	☐	☐	☐	☐	☐
D3. Those who are good at problem-solving can use different techniques to find solutions.	☐	☐	☐	☐	☐
D4. I have changed my mind of what I think is meant by problem-solving after using the Assessmake21 tool.	☐	☐	☐	☐	☐
E. Different skills – Social skills					
E1. Those who have good social skills are determined to turn ideas into action/make things happen.	☐	☐	☐	☐	☐
E2. Those who have good social skills can inspire others to reach their very best.	☐	☐	☐	☐	☐
E3. Those who have good social skills are good at balancing different views to find solutions.	☐	☐	☐	☐	☐
E4. I have changed my mind of what I think is meant by social skills after using the Assessmake21 tool.	☐	☐	☐	☐	☐

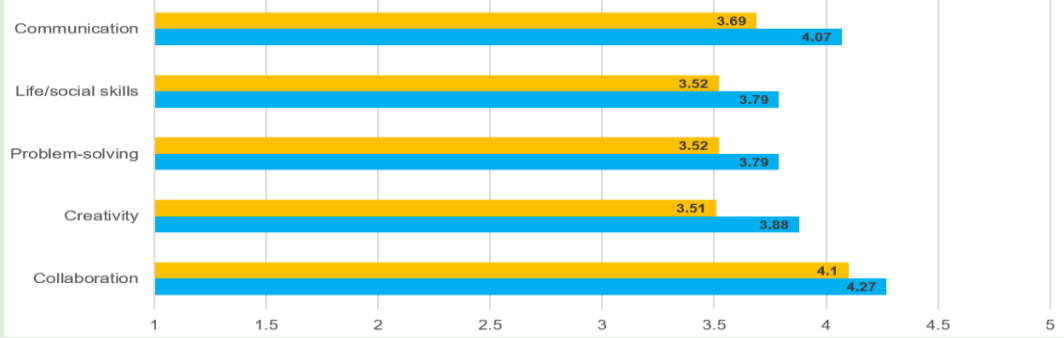|					
F. Different skills - Communication	☐	☐	☐	☐	☐
F1. Those who are good at communication can tell others about their ideas in many different ways, not only by talking.	☐	☐	☐	☐	☐
F2. Those who are good at communication can listen to others and hear what they really are saying.	☐	☐	☐	☐	☐
F3. Those who are good at communication can inspire and enthuse others.	☐	☐	☐	☐	☐
F4. I have changed my mind of what I think is meant by communication after using the Assessmake21 tool.	☐	☐	☐	☐	☐
G. Use of Assessmake 21 to evaluate/self-assess your own learning.					
G1. It was helpful to use the Assessmake21 tool to reflect on my own learning	☐	☐	☐	☐	☐
G2. It was difficult to use the Assessmake21 tool to reflect on my own learning.	☐	☐	☐	☐	☐
G3. It was fun to use the Assessmake21 tool to reflect on my own learning.	☐	☐	☐	☐	☐
G4. It was boring to use the Assessmake21 tool to reflect on my own learning.	☐	☐	☐	☐	☐

9 Appendix II

Country by Country Data from Pre and Post Questionnaires about understanding of 2st Century Skills

21st century skill	Cyprus		Greece		Ireland		Sweden	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Collaboration	4.03	3.78	4.09	4.33	4.27	4.10	3.95	3.96
Creativity	3.75	3.74	3.71	3.80	3.88	3.51	3.72	3.86
Problem-solving	3.52	3.62	3.64	3.84	3.79	3.52	3.84	3.94
Life/social skills	3.54	3.67	3.47	3.80	3.79	3.52	3.61	3.75
Communication	3.62	3.63	3.76	3.91	4.07	3.69	3.84	3.79

Graphical Representation of Same

Ireland

Skill	Orange	Blue
Communication	3.69	4.07
Life/social skills	3.52	3.79
Problem-solving	3.52	3.79
Creativity	3.51	3.88
Collaboration	4.1	4.27

Sweden

Skill	Orange	Blue
Communication	3.79	3.84
Life/social skills	3.75	3.61
Problem-solving	3.94	3.84
Creativity	3.86	3.72
Collaboration	3.96	3.95

10 Appendix III