Managing Affective-learning Through Intelligent atoms and Smart Interactions

D8.7 Report on Mainstream Education Case pilots

Workpackage	WP8 – Pilots in Education
Editor(s):	Rosaria Grazia Lo Russo and Marco Traversi (LCS) Mohammad Taheri, Helen Boulton (NTU) Annaleda Mazzucato (FMD) Marian Blanco y Juan Valdivieso (JCYL) Elena Milli, Stefano Cobello (PE) Ana Piñuela (ATOS) Dorothea Tsatsou (CERTH)
Responsible Partner:	La Cometa del Sud (LCS)
Quality Reviewers	Gosia Kwiatkowska (RIX), Hanna-Kaisa SAARI (AV)
Status-Version:	Final - v1.0
Due Date:	30/04/2017
Submission Date	12/07/2017
EC Distribution:	PU
Abstract:	This deliverable provides details for the Mainstream Education Case pilots as well as reports on the different measurable objectives set out for the specific pilots.
Keywords:	Driver Pilots; Mainstream education Case, Learning Graph, Learning Materials, Teachers Perspective, Learners perspective.
Related Deliverable(s)	D2.1 Formation of stakeholder groups; D2.2 Full scenarios of all use cases; Evaluation strategy

This document is issued within the frame and for the purpose of the *MATHISIS* project. This project has received funding from the European Union's Horizon 2020 Programme (H2020-ICT-2015) under Grant Agreement No. 687772

Document History

Version	Date	Change editors	Changes
0.1	06/06/2017	NTU	Initial draft
0.2	08/06/2017	NTU	Draft update
0.3	16/06/2017	Annaleda Mazzucato (FMD)	Input data on Driver Pilots
0.4	19/06/2017	Marian Blanco y Juan Valdivieso (JCYL)	Input on driver Pilots
0.5	21/06/2017	Elena Milli, Stefano Cobello (PE)	Input on driver pilots
0.6	26/06/2017	Rosaria Grazia Lo Russo (LCS)	input on driver Pilots & draft updated
0.7	03/07/2017	Mohammad Taheri (NTU)	Input on driver pilots
0.8	07/07/2017	Marco Traversi (LCS)	Review and final amendment taking into account internal reviewers' comments
0.9	08/07/2017	Ana Piñuela (ATOS)	Quality Check
0.91	11/07/2017	Marco Traversi (LCS)	New version with input from NTU and JCYL
0.92	12/07/2017	Ana Piñuela (ATOS)	Final Quality check
1.0	12/07/2017	Marco Traversi (LCS)	FINAL VERSION TO BE SUBMITTED

Table of Contents

List of Tables

List of Figures

List of Acronyms

Abbreviation / acronym	Description
ASC	Autistic Spectrum Case
ASD	Autistic Spectrum Disorder
CGDLC	Career Guidance Distance Learning Case
CLB	Cloud-based Learner's Space
DSS	Decision Support System
EE	Experience Engine
EOPPEP	EOPPEP is the National Organisation for the Certification of Qualifica and Vocational Guidance in Greece
FMD	Fondazione Mondo Digitale
HCI	Human Computer Interaction
ID	Intellectual Disability
ICT	Information and Communication Technologies
ITC	Industrial Training Case
IWB	Interactive White Board
JCYL	Consejería de Educación Junta de Castilla y León
KPI	Key Performance Indicator
LCDS	La Cometa del Sud
LA	Learning Action
LAM	Learning Action Materialisation
LG	Learning Graph
MEC	Mainstream Education Case
NTU	Nottingham Trent University
PA	Platform Agent
PC	Personal Computer
PE	Polo Europeo Della Conoscenza
PMLDC	Profound and Multiple Learning Disabilities Case
RIX @UEL	RIX Research and Media at the University of East London
SC	Sensorial Component
SEN	Special Education Needs
SLA	Smart Learning Atom
UoN	University of Nottingham
VET	Vocational Education and Training

Table 1: Definitions, Acronyms and Abbreviations

Project Description

MATHISIS is a 36 month duration project co-funded by the European Commission Horizon 2020 Programme (H2020-ICT-2015) under Grant Agreement No. 687772. It started on 1st January 2016.

One of the core objectives of MaTHiSiS project is to enhance learning environments and make use of computing devices in learning in a more interactive way, which will provide a product-system to be used in formal, non-formal and informal education. An ecosystem for assisting learners/tutors/caregivers for both regular learners and learners with special needs will be introduced and validated in 5 use cases: Autism Spectrum Case (ASC), Profound and Multiple Learning Disabilities Case (PMLDC), Mainstream Education Case (MEC), Industrial Training Case (ITC) and Career Guidance Distance Learning Case (CGDLC).

MaTHiSiS product-system consists of an integrated platform, along with a set of re-usable learning components (educational material, digital educational artifacts, etc.), which will respond to the needs of a future educational framework, and provide capabilities for: i) adaptive learning, ii) automatic feedback, iii) automatic assessment of learner's progress and behavioral state, iv) affective learning and v) game-based learning.

Within MaTHiSiS, an innovative structural tool of learning graphs is going to be introduced to guide the learner through the process of learning in the given scenario. To reach a learning objective, learner will have to "follow the path" of the learning graphs, built up on Smart Learning Atoms, which are certain learning elements that carry defined learning materials.

To ensure barrier free integration in the market, MaTHiSiS makes use of a range of interaction devices, such as specialized robots, mobile devices and interactive whiteboards. The consortium ensures easy-to-use solution with e.g. specialized graphical editor-like tool, allowing to easily create educational materials as well as the reusability within both mainstream education and vocational training setups.

Objectives of the project

A Cloud-based Learner's Space (CLS) will be developed to provide a system for adaptation/personalization in learning, interaction, data acquisition and analysis as well as content creation on the fly. This is a core component of the MaTHiSiS system which includes 3 crucial subsystems which create an innovative smart learning ecosystem: i) the experience engine (EE), a graph-based interactive storytelling engine, that manipulates interactive content that is later sent to a device of tutor's/learner's choice; ii) the learning graph engine, responsible for adaptation of the Learning Graph based on learner's behavior and interaction; iii) the Decision Support System (DSS) providing and collecting learning analytics and controlling synchronous and asynchronous interaction between devices. To ensure constant educational flow and augmented learner engagement, the emotion recognition and context aware cognitive/behavioral status extraction tools are introduced within the system addressed by the Sensorial Component (SC).

For the purpose of validating MaTHiSiS approaches in learning environment, a set of Smart Learning Atoms (SLA) is going to be created for defined use cases. Such SLAs will adapt to each learner in a different way based on her/his particular needs, profile, cognitive affective state, relevance to specific learning requirements and previous performance. Further, an editor-like tool is introduced to be able to transform educational material into MaTHiSiS Learning Materials usable by SLAs through Learning Actions. The learning graphs then are going to be deployed to interact with the CLS as well as some front-end tools for tutors and caregivers to enable creation, editing and authoring of the learning contents and learning experiences.

MaTHiSiS will support learning across a variety of learning contexts and, with the use of a variety of devices (robots, interactive whiteboards, mobile devices and desktop/laptop computers), with personalized and adaptable, time and location independent learning paths, being transferred

between the agents, always taking into consideration best knowledge and practices learnt from the previous device.

By the end of the project, MaTHiSiS will introduce a marketable innovation, aimed at the re-usability of educational and training content and fostering the interactivity between technology and learners/tutors/caregivers.

Executive Summary

This deliverable provides information on the outcomes and outputs resulting from the process of preparation and implementation of the first phase of Pilots in Education - Driver Pilots - for the Mainstream Education Case - MEC.

The scope of the Driver Pilots is to support the training of the system and testing users' behaviour in response to the MaTHiSiS prototype. The benefits associated with the users' trials are related to the identification of their reaction and interaction to the system, which provides experimental evidence to show technical issues as well as problems that users envisage and enables the design team to compare existing products as a way of considering future options.

The MaTHiSiS learning vision is to provide a novel advanced digital ecosystem for vocational training, special needs and mainstream education for both individuals with an intellectual disability (ID) and neuro-typical learners. This ecosystem consists of an integrated platform, along with a set of re-usable learning components with capabilities for: i) adaptive learning, ii) automatic feedback, iii) automatic assessment of learners' progress and behavioral state, iv) affective learning, and v) game-based learning.

In addition to a learning ecosystem capable of responding to a learner's affective state, the MaTHiSiS project will introduce a novel approach to structuring the learning goals for each learner. Learning graphs act as a novel educational structural tool. The building materials of these graphs are drawn from a set of Smart Learning Atoms (SLAs) and a set of specific learning goals which will constitute the vertices of these graphs, while relations between SLAs and learning goals constitute the graph's edges. SLAs are atomic and complete pieces of knowledge which can be learned and assessed in a single, short-term iteration, targeting certain problems. More than one SLA, working together on the same graph, will enable individuals to reach their learning and training goals. Learning goals and SLAs will be scoped in collaboration with learners themselves, teachers and trainers in formal and non-formal education contexts (general education, vocational training, lifelong training and specific skills learning).

The Mainstream education case report is specifically describing the piloting process to use the MaTHiSiS platform with mainstream students without any specific physical or mental need.

This testing process is particularly important both for the mainstream case itself because these children can also have relevant learning problems due to many different personal and familiar situations but also as a comparison reference for the other two more problematic cases of Autism and Profound and Multiple Learning Disabilities.

This MEC pilots are anyway particularly complex because the potential variety of situation are clearly much wider and it is also extremely interesting to verify the validation of the MaTHiSiS learning model in different national contexts and teaching methodological approach which is surely easier with mainstream students.

The most significant results will show up at the end of the piloting process which includes three different steps (Driven Pilots, Assisted Pilots, Real life pilots) which will provide at the end a full range of information to verify the validity of MaTHiSiS both for problematic cases but also for the mainstream ones taking in account different contexts and situations.

In the driver phase of the MEC the pilots ran in 3 different countries, the UK, Italy and Spain and from 7 different schools involving in general 16 teachers, 51 learners and 17 internal tutors.

The involved schools were the following:

- UK
  Nottingham Bluecoat Academy
  The Trinity Catholic School – Nottingham
- Italy

IC Rita Levi Montalcini School - Roma
I.C. Leonardo da Vinci – Bussolengo (Verona)
I.C. Don L. Milani, Sommacampagna (Verona)
Primary School I Circolo Cava De' Tirreni (Salerno)

- Spain
  CEIP "Miguel De Cervantes" - Valladolid

The main key results from this first piloting phase can be considered:

- A very positive attitude and a wide collaboration approach by the teachers and schools
- An interest, and often, a real enthusiasm by the learners
- A very positive vision of the potential education results of MaTHiSiS
- The need of a strong technical support especially for setting up the Pas

These first evidences need to be verified when the project will get the following steps and in particular when the teachers and tutors will need to run MaTHiSiS without any external support.

Internally, this deliverable serves as a detailed frame of reference for the evaluation of the MaTHiSiS Driver Pilots and as a starting point for the development of the second phase of the Pilots in Education - Assisted Pilots. For readers external to the project, this deliverable describes the process followed to elicit requirements, details of those requirements and their codification across the use cases the Use Cases, and the process of breaking learning materials down into SLAs and Learning Action for the MaTHiSiS platform to be piloted in a driver setting by users with a different spectrum learning disabilities. Finally, the document contains references to users' feedback gathered by tutors at the venues, regarding the pedagogical potential of MaTHiSiS in the context of mainstream education.

1 Introduction

The specific objective of this deliverable is to provide an overview of the implementation of the Driver Pilots phase for the Mainstream Education Case (MEC). This phase saw the close cooperation among pedagogical partners - representing the end users - and the technical partners - developing the MaTHiSiS system.

The involvement of the stakeholders started on M4 and the MaTHiSiS user centered approach was applied since the very beginning: pedagogical partners cooperated with teachers and practitioners working with MEC students and teachers in order to analyze the users' requirements. Once melted the latter with the technical requirements, different Learning Graphs and Learning Materials were developed thanks to a joint work of the pedagogical and technical partners. The arrangement of the Driver Pilots in each venue considered all the different aspects: training of the teachers, legal and security aspects, technical assistance.

The document is divided into the following sections:

1. Description of the Mainstream Education Case and associated challenges, goals and learning scenarios.
2. Driver Pilots preparation activities including: selection of stakeholders, analysis of user requirements, development of Smart Learning Atoms, venue setting and teachers training.
3. Pilot deployment plan, including details on Learning Materials used and feedback gathered from users.
4. General remarks from the teachers and learners.
5. Evaluation of the system.

This document is public, and intended to be read by those involved in education, particularly special needs education, willing to support a more inclusive pedagogical approach supported by ICT.

2 Mainstream Education Case

2.1 Brief Description MEC

This report is focused on Mainstream education cases which can be considered a full range of children without a specific physical or mental disorder and as a residual class once defined who is included in the AS and PLMD cases according to MaTHiSiS approach.

MEC children included in the research described in this report range mostly between the ages of 3 and 14 with some exception from 15 to 18 and are students who are usually very lively and busy in different activities, as it happens nowadays, due mainly to the limited free time of the parents from job activities.

So, they are often engaged not only in school activities but in various extra school ones ranging from sport, mostly for males, and dance or rhythmic gymnastics, mostly for females, which are the most talked about, in Italy at least.

They can also have good scholastic performances that go from good to distinguished as an evaluation. However, they can also struggle to be attentive in the classroom, often distracted and being very lively sometimes and they may be disturbing for the entire class and interfere with the school lessons.

These children are very busy during the day as working parents cannot devote all the time that they would need. However, of course, children are disrupted and can discharge this discontent with uneducated attitudes.

Some of them are involved in other cultural or artistic activities like playing music, drawing etc., and can show great aptitude to subjects such as art design and theater which allows them to express their feelings. Through this we realize that in order for them to flourish in their experiences, they must be seized and valued to meet their full potential.

The main issue is they often lack a stable and continuous relation with their parents who are usually busy at work and miss an everyday reference. For this reason, they can feel that it is difficult to interact with their peers or adults, often hiding themselves behind videogames or smartphones.

2.2 Associated challenges, Goals and Example Scenarios

The challenge for MEC children is to recognize if their learning abilities are improving or if it is time to consider a new method. Although this is not the linearity they experience every day this new method is suggested by MaTHiSiS which uses new technologies, experimenting with a new non-linear approach.

Being that these technologies are familiar to the 3-14 year old age group they will be drawn to them. However, there is also the risk of boredom if the system does not compare to the games that they are familiar with.

The purpose of MATHISIS is also to make MEC children collaborate with special needs children to achieve this goal. By using the same LMs and playing at the same time or collaborating with their peers.

Because of this reason the choice of the MEC children was done amongst those who are in the same class with ASC and PLMDC children. Through the process of interaction between friendly sensitive children and those with ASC and PLMDC this can help to overcome small but significant daily obstacles.

A further challenge is to let MEC children share the same learning experience with the other two categories in order to observe the reactions they can have in unusual situations.

3 Pilots Deployment Plan

3.1 Pilots Phases

MaTHiSiS implements a phased approach for the deployment of the pilots in three conceptually different and consecutive phases for each use case, introduced by a user and system requirements elicitation phase and data acquisition phase:

- **Driver Pilots**, which initiated the procedure in May 2017: These pilots ran under the total supervision of the MaTHiSiS consortium and practically MaTHiSiS technical partners configured and setup the system.
- **Assisted Pilots** will run during November 2017: The pilots ran with the assistance from the MaTHiSiS consortium. People at the venues will setup and configure the system under MaTHiSiS consortium physical guidance. Based on the evaluation results of Driver Pilots outcome, leading to the refinement of component and system level technology consolidation, an enhanced version of the final prototype will be tested during this phase.
- **Real-life Pilots** will run in 2018: final tests will occur. These pilots will run autonomously by people at the venues.

3.2 Stakeholders Roles

The following is a review of the role descriptors as described in MaTHiSiS deliverable "D2.2 Full scenarios for all use cases" [3] and "D2.4 Fully System Architecture"[4].

Administrator (Super-admin - Pilot site admin): Users with this role were able to:

- Configure MaTHiSiS eco-system using the Platform Configuration UI (MaTHiSiS User Management, Resources Management: selection of PAs, add Content repositories, Manage info about the Local Networks
- Manage learning processes in case of need for initial testing. User with this role will be able to conduct all actions described for teacher role and learner roles.

Tutor/Teacher: those whose role is to instruct or teach students about a subject in accordance with a pre-defined curriculum. Tutor are partners' organisation researchers whose specific role is to advise on the development of LGs and LMs, train and assist teachers and other practitioners involved in piloting MaTHiSiS platform. They have pedagogical knowledge and skills that will allow them to:

- Set up a learning experience (define learning graphs, create SLAs, LOs, set initial and modify edge weightings, select supporting learning materials, define learners profile information)
- Manage a learning process through the assessment of the attainment of specified learning goals, monitor the performance of different learners during the experience and make modifications to such experience considering the recommendations proposed by the MaTHiSiS Decision Support System (DSS).

Special Needs Teacher is a teacher or psychologist specifically employed to work with children and young people who need extra support, or require an advanced programme of learning in order to reach their full educational potential. These teachers may work with individuals who have physical disabilities, sensory impairments (i.e. hearing or visual), speech and language difficulties, learning difficulties such as dyslexia, conditions such as autism, social, emotional and mental health needs, or have a combination of these difficulties. They work as extra support besides the school hours or within the mainstream classes. This last, is the case of countries such as Italy and most of the cases in Spain, where special needs students are enrolled in mainstream schools.

Parent/Caregiver: Users with responsibility for care of the student. They will be able to:

- Start a learning experience for the learner

- Select complementary resources from the list of resources provided in the LOs
- Visualize a learner performance information and profile

Learner: This role is the most important stakeholder in MaTHiSiS. There are two different types of learners:

- Supervised learner who will use the platform under supervision either because they will use the platform within the school educational path, or they have special learning needs or they are minors without special needs.
- Independent learner for those who are advanced learners even when they use the platform within the school educational path.

4 MEC Pilots Preparation Activities

4.1 Stakeholders Selection

The following is a review of the Description of Stakeholders included in MaTHiSiS deliverable D2.1 [1].

Two of the organisations selected to organise the pilot are based in UK, one enrolling students from 11 to 18 years, both of them are private mainstream schools. Four are Italian public mainstream schools based in 3 different regions, two in the north of Italy, one in the centre and one in the south. All of them enroll students among 3 and 14 years old. The Spanish school is also a mainstream one with students ranging from 3 to 11 years.

4.1.1 UK

4.1.1.1 University of Nottingham – UoN, The Nottingham Trent University - NTU

Organisation Name	**Nottingham Bluecoat Academy**
General Description of the Organisation	The Nottingham Bluecoat Academy is a Church of England School with pupils aged 11-18 years, and a primary school (3-11 years) currently being built. The school operated across two campuses. The Nottingham Bluecoat School was founded as the first charity school in Nottingham in 1706. Today the School is a vibrant, diverse community of almost 2,000 learners including SEN and children from mixed ethnicity backgrounds. The School is founded on the principle of a Christian faith education for all. Their mission is to provide the best possible education in a supportive and disciplined environment where each student is seen as an individual. The school has strengths in technology, science, ICT/Computing, arts numeracy and literacy. The school believes that effective learning takes a multitude of forms. Some of this happens in traditional classrooms with familiar methods but the school promotes new ways of learning which include taking learning beyond the classroom, such as through their international links with South Africa, Italy, France, Germany and Jamaica to allow students to explore unfamiliar places and enrich their knowledge and understanding.
Description of the Characteristics of the Services users at that Organisation	Children are aged 11-18 years. The school is currently building a primary school which will include children aged 5-11 years. Some children may have learning impairments such as English as a Second Language, autism (low level), and SEN.
Support Mechanisms for the use cases	Children who are on action/action plus [26] (different types of educational support available to children with SEN) may have teaching assistants in some, or all lessons, depending on the needs of the students. The teachers involved in the project are all computing teachers and therefore have experience of using robots and mobile devices. While all teachers can use an IWB, not all classrooms have them. In terms of this project some students may need larger text and different coloured backgrounds.

Table 2: Nottingham Bluecoat Academy

Organisation Name	**The Trinity Catholic School**
General Description of the Organisation	This is an 11-18 Catholic school The Trinity School is a Catholic specialist secondary school. The school became a specialist arts college in 2002 and was awarded a second specialism in mathematics and computing in 2007.Over 80% of students are baptized Catholics and all are practicing members of a church. The majority of learners are White British, although the proportion of learners from other ethnic 8 backgrounds is higher than that found in most schools, which reflects the local population. This proportion includes Asian students of Indian or Pakistani heritage and students of Black Caribbean or Black African heritage as well as an increased proportion of students from European Union backgrounds. The number of students

	whose first language is not English is around average but growing. The school serves a wide, mixed area of the city of Nottingham with some areas of significant disadvantage. The overall ability of students on entry is around average. The number of students who have learning difficulties and/or disabilities is below average, as is the number with statements of particular need. Source [2]: https://www.trinity.nottingham.sch.uk/general/2016/Trinity_Ofsted_2008.pdf
Description of the Characteristics of the Services users at that Organisation	11-18 school. Children are taught in mixed groups. Some children will have impairments such as EAL, autism (low level), EACP, SEN.
Support Mechanisms for the use cases	There are no teaching assistants for computing. Teachers have experience of using IWBs and mobile devices. All classrooms have IWBs and PCs. Some students may need larger text and different coloured backgrounds.
Motivation to participate	The teachers will be able to provide initial user requirements.

Table 3: The Trinity Catholic School

4.1.2 Italy

4.1.2.1 Fondazione Mondo Digitale – FMD

Organisation Name	**IC Rita Levi Montalcini School**
General Description of the Organisation	Primary and secondary first grade public school (students aged 3 to 14 years) known for the training of teachers linked to new technologies and initiatives related to innovative teaching approaches focusing on collaborative learning, student centred pedagogy, flipped classroom. It counts on a professionally prepared staff, in particular regarding the education of students with special needs. The class of approximately 24 students selected to take part in the pilot enrolls students aged 9/10 including 8 ASD and 5 students with learning difficulties. The school is equipped with interactive whiteboard, PC and 6 tablets.
Description of the Characteristics of the Services users at that Organisation	16 students aged 9/10. Among them 5 students demonstrate specific learning difficulties, in some cases associated with a general global delay and behavioral disorders.
Support Mechanisms for the use cases	The pilot was organised at the school venue providing teachers the required technical support and training. 4 teachers, 2 in-service, and 2 support teachers were involved, all with experience using ICT for teaching and learning. The class was equipped with IWB, PC and 6 tablets, and FMD provided the rest of equipment based on MaTHiSiS requirements
Motivation to participate	Enhance teacher's skills using ICT for teaching, enhance the development of student pedagogical approach, developing personalised learning experiences and inclusive learning environment.

Table 4: IC Rita Levi Montalcini School

4.1.2.2 Polo Europeo della Conoscenza - PE

Organisation Name	**I.C. Leonardo da Vinci – Bussolengo (VR)**
General Description of the Organisation	Istituto Comprensivo Leonardo da Vinci includes about 2000 students from 3 to 14 years old. It is a public school network consisting of 9 different schools (5 preschools, 3 primary schools, 1 middle school) in a high plain and hilly area around Verona. The network can be further broken down into: 5 preschools with students from 3 – to 5 years old 3 Primary schools with students aged 5 – 10 years old 1 Middle schools with students aged 10 – 14 years old
Description of the Characteristics of the Services users at that Organisation	There are about 69 students with a Learning Disability (3-14 years old) at various levels (Cerebral Palsy, Down Syndrome, Autistic Spectrum), and about 30 special need teachers to support them. All will participate in the project as part of their curricular.

Support Mechanisms for the use cases	Teachers and special needs teachers know ICT robotics, the use of computers with Microsoft, access to the Internet and a more limited way Linux. A range of tablets, the IWB and a robot NAO were also available for use in the project.
Motivation to participate	I.C. Leonardo da Vinci participated to the driver pilot phase of the project to improve the ICT competences of the teachers.

Table 5: I.C. Leonardo da Vinci, Bussolengo (VR)

Organisation Name	**I.C. Don L. Milani, Sommacampagna (VR)**
General Description of the Organisation	Istituto comprensivo Don L. Milani includes about 1400 students from 3 to 14 years old. It is a public school network consisting of 5 different schools around Verona. There are about 26 students with a Learning Disability at various levels (Cerebral Palsy, Down Syndrome, Autistic Spectrum, and about twenty special need teachers to support them. The network can be further broken down into: Three preschools with children from 3 – to 5 years old Five Primary schools with pupils aged 5 – 10 years old Three middle schools with students aged 10 – 14 years old
Description of the Characteristics of the Services users at that Organisation	There are about twenty students with a Learning Disability (3-14 years old) at various levels (Cerebral Palsy, Down Syndrome, Autistic Spectrum), and about twenty special need teachers to support them. All will participate in the project as part of their curricula.
Support Mechanisms for the use cases	Teachers and special needs teachers know ICT robotics, the use of computers with Microsoft and Linux, access to the Internet. A range of tablets and the IWB were also available for use in the project.
Motivation to participate	I.C. Don L. Milani participated to the driver pilot phase of the project to improve the ICT competences of the teachers.

Table 6: I.C. Don L. Milani, Sommacampagna (VR)

4.1.2.3 La Cometa del Sud - LCS

Organisation Name	**PRIMARY SCHOOL I CIRCOLO CAVA DE' TIRRENI**
General Description of the Organisation	Primary public school (students from 6 to 10 years based in Cava dei Tirreni (SA). The school is a primary public school (students aged from 6 to 10 years old based in Cava dei Tirreni (Salerno). Since 2013, the "Primo Circolo Didattico" has 3 different locations in different areas of the city but the pilots took place in the main one in the city centre named "Don Bosco" in Corso Mazzini,n.10. The school has two canteens for the kids and for the afternoon classes, a fully equipped, a modern gym, 25 classrooms with a LIM, a children friendly library, a multi-media library, some labs: informatics, linguistic (LIM), multi-media (LIM), scientific (LIM), musical (LIM), historical - geographical and artistic.
Description of the Characteristics of the Services users at that Organisation	There are seven children involved from 6 to 10 years and they were chosen by the school teachers among those who are more sensitive and friendly towards their peers with special needs to be able to help them in case of need. They have a good schooling but are lively children and they often distract themselves and so engaging them is a way to make them excite about a new way of doing lesson.
Support Mechanisms for the use cases	Three teachers are involved (both support specialist for special needs). Two LCS tutor are also present during the pilot realized by using a tablet and a smartphone in a dedicated setting which is the Hi-tech lab of the school.
Motivation to participate	The school is a looking forward school with an open approach to introduce innovations which can be appealing to these students. As a result, there is a large number of enrollment for students with special needs. The school has more than a thousand students and has participated with great interest and motivation for introducing innovations and new ICT tools that can help improve the quality and learning for pupils with disabilities and how to train their teachers.

Table 7: Primo Circolo Didattico di Cava de' Tirreni (SA)

4.1.3 Spain

4.1.3.1 Consejería de Educación - Junta Castilla y Leon - JCYL

Organisation Name	**CEIP "MIGUEL DE CERVANTES"**
General Description of the Organisation	This is an infant and primary school based in Valladolid. • There are around two hundred pupils, with ages ranging from 3 to 12 years old. • School teachers have received training on IWB and mobile devices for educative use, management of ICT resources
Description of the Characteristics of the Services users at that Organisation	Main facts: • This is an infant and primary school. • Over 200 pupils attend, and ages range from 3 to 12 years old. • Students are bilingual (with English.) • School teachers have been trained in using smart boards for educative uses. The head team is willing to participate in projects like MaTHiSiS that enrich either the pupils or teachers. Students' age range from 3-12 years, and are in mainstream education. In each class there are at least 2 students with learning difficulties. Higher numbers of students can be recruited if needed.
Support Mechanisms for the use cases	Two classes, with up to thirty students will be involved in the MaTHiSiS project. Two to three teachers will also be involved. Teachers have experience in using smart boards, tablets and computers, but not with robots. There are smart boards in every class room that can be used for the project.

Table 8: CEIP "MIGUEL DE CERVANTES"

4.2 User and system requirements elicitation phase

Following stakeholder's selection phase, users and system requirements elicitation phase included definition of the use cases, elicitation of the user and system requirements, modelling of the dynamic assessment, definition of the system architecture. In this phase, the core development took place, regarding the adaptation and knowledge creation, the optimization modules and the collaboration platform, to release the first integrated prototype to be tested during the Driver Pilots phase, following integration guidelines. Based on the elicitation requirements resulting in D2.2 from semi-structured interviews with domain experts (teachers, trainers & pedagogists) for each of the Use Cases, technical partners compiled the initial set of User Stories for MaTHiSiS and defined the core functionality of the platform and its components, presented in D2.4 Full System Architecture.

4.3 Data Acquisition Phase

Collection of data for training affect analysis algorithms and define the data models have been carried on by partners in cooperation with selected stakeholders at the school's venues. In this phase, the core development took place, regarding the adaptation and knowledge creation, the optimization modules and the collaboration platform, to release the first integrated prototype to be tested during the Driver Pilots phase, following integration guidelines.

More technical and procedural details about the data acquisition pre-pilot can be found in Deliverable D4.2.

In short, the data acquisition tool aimed to gather ground truth regarding user (learner) behavior that reflects their affective state during the actuation of the learning process. The affective state can be derived by both spontaneous emotions such as happiness, sadness, surprise etc. and composite emotions that build up in the course of the users' interaction with the learning environment, such as engagement, frustration etc. The purpose of gathering data was to create a comprehensive dataset, based on which the algorithms of the MaTHiSiS Sensorial Component (SC) and Interaction with Platform Agents (IPA) modalities can be trained with in order to detect cues over the learners' affective behavior.

Following the set of activities for calibration purposes and gathered minimal metadata related to user learning style to facilitate indexing of the acquired data, the learner was asked and guided to conduct the core data gathering task, where s/he was recorded as s/he interacted with the data acquisition tool in scripted activities/games. S/he was positioned (sitting or standing per specific activity) in front of a computer screen, with two cameras (Kinect v2 and web camera) placed opposite her/him in predefined positions, except in the case of inertial data gathering, where the learner interacted with a mobile device, where no cameras or particular positioning was required.

The system presented one or more activities to the learner, which s/he was called to complete to the best of her/his abilities. Finally, the collected data were annotated by tutors at the venue in collaboration with teachers, concerning emotions, with a set of predefined labels, corresponding to 3 salient affect states of the theory of flow: engagement, frustration (anxiety), boredom.

The sensorial cues of the learners' affective state in MaTHiSiS is captured through facial expressions analysis, gaze estimation, skeleton motion analysis, speech-based emotion recognition and inertia sensors input analysis for mobile devices, as described in Deliverables "D4.1 MaTHiSiS Sensorial Component" [6] and D4.2 "MaTHiSiS Sensorial Component" [5]. In general, during data gathering a wide range and variety of all data, implying diversity in users, was captured and annotated. The sensory data recorded in particular are HD video (from Kinect v2, including depth and information that accrue from it, such as head pose, body skeleton), non-HD video (web camera – also emulating NAO cameras), audio (from Kinect v2, including sound direction) and mobile inertia sensory data (touch, proper acceleration, orientation/rotation, etc.).

4.4 Development of Smart Learning Atoms

4.4.1 UK

4.4.1.1 Nottingham Trent University – NTU and University of Nottingham - UoN

In the mainstream education case the structure of the learning graphs is much more complex than the other use cases. This makes the granularity of the SLA scope a far larger body of understanding. In this respect the MEC have been developed with the teacher support to as closely represent the learning objectives of each class session. Each SLA closely incorporated a series of material that would transfer the learning of a single learning objective to the students. With this one to one relationship the transition of the teacher's learning material to the MaTHiSiS system became a simple process.

4.4.2 Italy

4.4.2.1 Fondazione Mondo Digitale - FMD

FMD delivers their Driver Pilots at IC Rita Levi Montalcini where ME, AS and PMLD students are enrolled in the same classes. In service teachers and support teachers, as well as parents were involved identifying specific Learning Goals for each pupil personalized learning path, social and learning environment. The working group tried as much as possible to develop LGs suitable for mainstream students but adequate for special needs students, in order to consolidate the inclusive approach carried on by the school and teachers. These SLAs were discussed and validated with all teachers and tutors involved in the Pilots in order to make sure that they were in line with the learning path of their students enrolled in the mainstream classes.

The Learning Graph developed for the ASC includes the following SLAs concerned the following area related to cognitive, motor, communication/socialization skills:

- Motor sequencing and spatial coordination
- Improve motor coordination (arm and leg coordination, hand-eye coordination)
- Improve literacy
- Improve language comprehension

- Express feelings/Social perspective taking

The above atoms were included in the Cause and Effect Learning Graph. The learning progress was monitored and recorded, the level of support required and prompting was also taken into consideration.

4.4.2.2 Polo Europeo della Conoscenza - PE

PE delivers the Driver Pilot in two different venues and three classes, the teachers identified specific Learning Goals for the pupils involved in this phase, considering the curricular, the environment and the level of development.

At the I.C. “Leonardo da Vinci” of Bussolengo (Verona) the SLAs developed were:

- Motor sequencing and spatial coordination
- Synonyms / antonyms
- Semantic fields establishment (conceptual networks)
- Emotional awareness

At the I.C. “Don L. Milani” of Sommacampagna (Verona) the SLAs developed were:

- sequence reproduction
- Emotional awareness
- Basic emotion recognition
- Basic emotion expression

4.4.2.3 La Cometa del Sud - LCS

LCS did not take part in this project phase at the first moment and followed up developing and adapting the SLAs developed by FMD to the local school of “Primo Circolo Didattico” in Cava de’ Tirreni (SALERNO):

- Motor sequencing and spatial coordination
- Improve motor coordination (arm and leg coordination, hand-eye coordination)
- Improve literacy
- Improve language comprehension
- Express feelings/Social perspective taking

4.4.3 Spain

JCYL delivered the Driver Pilots in two different classes at the same school. The teachers identified specific Learning Goals for the pupils involved in this phase, considering curriculum and level of development.

At the CEIP “Miguel de Cervantes” the SLAs developed were:

- Visual attention
- Hearing attention
- Synonyms / antonyms
- Semantic fields establishment (conceptual networks)
- Number quantity correspondence
- Discrimination greater than/less than

4.5 Setting of the venue

4.5.1 UK

4.5.1.1 Nottingham Trent University – NTU and University of Nottingham - UoN

Three venues were used. Two were from the same school body and used the same learning materials. Pilot session schedule was arranged ahead of time with the teachers. And teachers were reminded on the day to be prepared for pilot sessions, this meant the teachers could allow the pilot partners early access to the venue to setup before the students arrived. The technical setup was carried out as close as possible to the MaTHiSiS pilot study specification. Two simultaneous instances of the platform were used when circumstances allowed and participants were chosen from students who had written consent at random.

4.5.2 Italy

4.5.2.1 Fondazione Mondo Digitale - FMD

FMD implemented the Driver Pilots at I.C. Rita Levi Montalcini based in Rome with one primary school class, in order to experiment the use of the platform in both the context of a mainstream educational environment. School teachers had previous experiences using ICT for teaching and learning and had a particular interest to cooperate in experimenting new pedagogical approaches for special needs education. FMD equipped the venues based on MaTHiSiS requirement including kinect, tablets, smartphones, wide screen and laptops, ensuring that the organisation of the setting could ensure a proper friendly environment for the students. The duration of the sessions was about 20 minutes per students accompanied by an explanation of the aims of the experimentation before its start and by a final feedback where students could prompt and be aware of the whole process of MaTHiSiS research feeling protagonists.

4.5.2.2 Polo Europeo della Conoszenza - PE

PE planned to run the Driver Pilots for the MEC use case in 2 different venues: the I.C. “Leonardo da Vinci” of Bussolengo (Verona) with children aged from 6 to 8 and the I.C. “Don L. Milani” with student aged 12 and 13. Each venue is equipped by the partner with laptop, kinect sensor, webcam, tablets and at I.C. Da Vinci the use NAO robot. In all the two venues the pilot took in a dedicated room with good internet connection and enough space to let the pupils feel comfortable. The duration of the session is of about 15 minutes. Longer sessions, breaks and pauses are foreseen due to technical reasons.

4.5.2.3 La Cometa del Sud - LCS

LCS realized the Driver Pilots in a single location at the primary school “Primo Circolo Didattico” in Cava dei Tirreni (Salerno) in a location in the city centre. The school is one of the best ranked in the area and particularly well equipped, compared to the area average. The school has in particular an ICT LAB equipped with 12 pc and several tablets. In this lab LCS settles the additional MaTHiSiS equipment such as a kinect, a tablet, a smartphone and a wide screen. The students work separately and jointly in the lab with sessions of different duration according to the needs and skills of the students from 10 to 40 minutes and also due to some mis-functioning of the system.

4.5.3 Spain

4.5.3.1 Consejería de Educación Junta de Castilla y León - JCYL

JCYL delivers their Driver Pilots at CEIP “Miguel de Cervantes”. Venue has IWB and computers and JCYL equipped them with kinect camera, and Nao robot as well as tablets on the cases those from the school didn´t answer to the requirements placed my technical partners of the project. The venue had a dedicated room to run driver pilots with good internet connection and comfortable enough

either for pupils and teachers. Duration of sessions was about 20 minutes. The aim of this driver pilot was to check how the platform individualizes student's paths of learning depending on their different characteristics and needs.

4.6 Teachers training

4.6.1 UK

4.6.1.1 Nottingham Trent University – NTU and University of Nottingham - UoN

Teacher training was initially planned to gather feedback from the teachers in the pilot studies on the Learning Graph creation tool and also to train them on using the platform. However much of the training has been postponed to the next pilot studies (assisted pilot studies) because the platform was not mature enough for the use of the teachers. Other issues included learning graph creation not facilitating the normal learning materials of MEC meaning that the materials would not transition in the way that the teachers would expect. Other bugs and usability issues meant that the platform was not ready for the teachers' consumption. It was decided to maintain school enthusiasm and teacher participation by introducing the training when the platform is more ready and in a working state.

4.6.2 Italy

4.6.2.1 Fondazione Mondo Digitale (FMD)

4 Teachers from the I.C. Rita Levi Montalcini were actively involved by FMD since the very beginning of the project in the development of the LGs and user profiles. During the Pilot phase, an introduction to the system functionalities was provided by FMD tutors followed by a more detailed explanation during the implementation of the sessions with the students. As the system was not yet mature enough to be user friendly, FMD tutors permanently assisted the implementation of the pilots.

4.6.2.2 Polo Europeo della Conoscenza (PE)

PE organised a first workshop introducing the use of the Learning Graph in January 2017, once the platform was ready the three teachers and practitioners involved in the pilot were introduced to the use of the system by the tutors, but they still need help to interact with the system.

4.6.2.3 La Cometa del Sud (LCS)

LCS had an introduction and training meeting with the school teachers in September 2016. At that meeting they would involve teachers from different schools while afterward the driver pilots were run only in one school during the months of May and June 2017 with three tutors from staff and a group of nine local teachers (3 involved for MEC case). The interaction with the teachers were constant during the pilots as they need support to run them because they do not have any ICT skill and the ICT support from the school was present only occasionally.

4.6.3 Spain

4.6.3.1 Consejería de Educación Junta de Castilla y León - JCYL

JCYL started to work on the issues related to MaTHiSiS and the MEC venues during 2016. In the CEIP "Miguel de Cervantes" there are 3 teachers involved in the MaTHiSiS driver pilots. All of them started to work with JCYL in 2016 in the creation of the Learning Graphs and, before the driver pilots took place, the teachers provided the information required to fill the learning profile of the MaTHiSiS platform and they were introduced to MaTHiSiS. All the teachers of this school are competent in the use of ICT technology applied to education and they were very enthusiastic at testing the MaTHiSiS system. During this phase, as planned in the driver pilots, technical on-site support from ATOS was provided to use the system.

5 MEC Driver Pilot Execution

5.1 Introduction

FMD organised the Driver Pilots within one mainstream class including also special needs students, of a public primary school based in Rome. 16 mainstream students were involved, among them 5 manifesting learning difficulties not included in the autistic spectrum. The venue was equipped based on MaTHiSiS requirements and the environment was prepared in order to be comfortable for the pupils. The project and objective of the Driver Pilots were introduced to students highlighting their active role in the experimentation and its aim. Information regarding the concrete activities part of the pilot was also provided. Pupils were committed to cooperate with the research phase of the project. FMD tutors assisted the pilot for its entire duration, dealing with teachers in relation to the student during the sessions' implementation. Each student was involved in 2 sessions of approximately 20-30 minutes each including a final exchange of feedback between the pupil and the tutor. Each pupil was also invited to share his/her thoughts with the other mainstream and special needs students taking part in the pilots. Interested parents also assisted the sessions in some of the cases.

PE organized the Driver Pilots in two different schools enrolling special needs students within the mainstream classes: two classes of primary school (first and second grade) and two students from two different classes of the middle school. A total of 14 learners were involved in the project. The teachers were involved early in the project and on January they received a first introduction to the functionalities of the MaTHiSiS system. They built the Learning Graph for their pupils considering their educational needs and the inclusion within the mainstream class. The venues were equipped with the required materials and Platform Agents (laptop, webcam, kinect sensor, tablets and NAO robot) and a dedicated room was prepared in order to let the tutors form PE check the possible technical issues without interfere with the lessons in the classroom. The piloting period was mainly during the last two weeks of school, it was possible to have only one session per pupil.

LCS organized the pilots on one site, the primary school Primo Circolo Cava de' Tirreni, and the involved 7 children from 6 to 10 years. The pilot implementation seat is a computer laboratory with 15 pc working stations. The project and the pilot objectives were presented to students underlining their active role in the experiment and in his final purpose. They were also informed by some concrete pilot activities and their reaction was interested and joyful. Tutors assisted the teachers throughout the duration of the pilots taking care of the relationship with teachers and children. The children came in pairs, mostly attending the same class, at different times during school time and each of them was engaged in running the pilot from 10 to 20 minutes. At the end there was an exchange of thought between students, teachers and tutors and between the two children involved in the pilot.

JCYL organized the driver pilots in an infant and primary school with learners from 3 to 12 years old, in two mainstream classes including also special needs students (2 per classroom). A total of 6 learners were involved in the Driver Pilot phase. Most of the teachers from these venues have been involved in the project since March 2016, when they were interviewed for the identification of the requirements, and they started to work on the creation of the different Learning Graphs adapted to the learners. The venue had computers, IWB and they were also provided with a NAO robot, kinet cameras and some tablets. The driver pilots were held in one session during June.

5.2 Stakeholders involved

Driver Pilots were mostly organized at the venue of the school or organization selected. Each piloting partner agreed with teachers and practitioners at the venue about the setting organisation in order to conciliate technical requirements and the necessity to guarantee users comfort and familiarity with the environment, not affecting pilots' outcomes and comply with ethical requirements. The

system ensured data protection and parents, teachers and students were informed of the data collection as a priority gathering informed assent.

The class or lab dedicated to the Driver Pilots was equipped with different Platform agents (PAs): a laptop, Kinect v2, high-resolution web camera, mobile device, NAO robot, IWB. Two desks and chairs were usually at disposal, one of the desks for the laptop running MaTHiSiS and the other as a support for students with difficulties handling the devise. One teacher/teaching assistant, one researcher/tutor, one technician composed the teamwork dedicated to each of the student during the piloting sessions.

Tutors were trained by their organization on MaTHiSiS functionalities and pilot schedule, providing guidance on the relationship to keep with teachers and students at the pilot venue. Approximately fourteen tutors were actively involved in the Driver Pilots, besides technical assistants, providing support to teachers both interacting with the platform All of them with pedagogical skills and experience working in the context of education.

Teachers and practitioners involved in the pilot were provided with information and training regarding the objectives and procedures of the MaTHiSiS platform and Driver Pilots. Their expectations regarding the platform functionalities were high and they were strongly committed to contribute to the research and highlighted the need for more time to build their confidence using the system once enough mature to be integrated in the daily activities with students. Approximately 16 teachers were involved and participated with interest and many expectations in the Driver Pilots across the different counties involved.

Students also were provided with an overview of the project highlighting their active contribution towards its objectives participating in the pilots. This approach motivated students, who were constantly collaborative during the pilots' execution and aware of the technical issues entailed in a research project. Approximately 51 students, aged 6 to 19, interacted with MaTHiSiS platform, engaged in 1 up to 5 sessions each of 10 to 40 minutes. They also were very much involved and enthusiastic about the process.

The time partners dedicated to the Driver Pilots, and the tutors' involvement, was duplicated as for the technical assess of the system in real time, crashed adjustments and exchange of information between partners, as well as students need for periodic breaks, often during the sessions or between them, considering behavioral disorders, hyperactivity and attention deficit.

5.2.1 UK

Nottingham Trent University – NTU, University of Nottingham – UoN	
Number of tutors involved	2
Number of teachers involved	2
Number of students involved	4

Table 9: Bluecoat School

Nottingham Trent University – NTU, University of Nottingham - UoN	
Number of tutors involved	2
Number of teachers involved	1
Number of students involved	4

Table 10: Trinity Catholic School

5.2.1 Italy

Fondazione Mondo Digitale– FMD	
Number of tutors involved	3 + 1 technician
Number of teachers involved	4 teachers, 2 in-service, and 2 support
Number of students involved	16

Table 11: IC Rita Levi Montalcini School (Rome)

Polo Europeo della Conoscenza – PE	
Number of tutors involved	2
Number of teachers involved	1
Number of students involved	2

Table 12: Istituto Comprensivo Don Milani (Sommacampagna)

Polo Europeo della Conoscenza – PE	
Number of tutors involved	2
Number of teachers involved	2
Number of students involved	12

Table 13: Istituto Comprensivo Da Vinci (Bussolengo)

La Cometa del SUD - LCS	
Number of tutors involved	3
Number of teachers involved	4
Number of students involved	7

Table 14: Primary school I Circolo Cava De' Tirreni

5.2.2 Spain

Consejería de Educación – Junta de Castilla y León - JCYL	
Number of tutors involved	2
Number of teachers involved	2
Number of students involved	6

Table 15: CEIP Miguel de Cervantes

5.3 Users Characteristics, Physical, Social, Learning Environment

5.3.1 UK

5.3.1.1 Nottingham Trent University – NTU and University of Nottingham – UoN

Organisation Name	*Bluecoat Academy*
Duration of the sessions	6 weeks
Number of sessions per student	6 – 3 sessions with 2 different groups
Description of physical environment	Standard computing classroom with 30 stand alone PCs. Interactive whiteboard at front of class. Data was collected from 2 students with each group.
Description of social environment	1 teacher, 2 students for each session The system ensured data protection and parents, teachers and students were informed of the data collection prior to the sessions.
Description of learning environment	Students were learning to use Excel. Learning Graphs were created prior to the lesson. Ethics permission was gained from each student's parents prior to the lessons.
Teachers involved (number and subjects)	Sophie Higson and Steve Li were both involved. Each teaches one of the groups.
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	Data was collected from 2 students in each visit to each class. The students were in Year 7, aged 11 -12. They had no special educational needs. Both genders were involved.

Table 16: Bluecoat academy

Organisation Name	*Trinity Catholic School*
Period of the sessions	6 weeks
Number of sessions	3 sessions with one group.
Description of physical environment	Standard computing classroom with 30 standalone PCs. Interactive Whiteboard at front of class.Data was collected from 2 students with each group where possible.
Description of social environment	Students were learning to use Python, programming language. Learning Graphs were created prior to the lesson. Ethics permission was gained from each student's parents prior to the lessons.
Description of learning environment	1 teacher, 2 students for each session. The system ensured data protection and parents, teachers and students were informed of the data collection prior to the sessions.
Teachers involved (number and subjects)	Chris Simcox was the teacher involved.
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	Data was collected from 2 students in each visit to each class. The students were in Year 7, aged 11 -12. They had no special educational needs. Both genders were involved.

Table 17: Trinity school

5.3.2 Italy

5.3.2.1 Fondazione Mondo Digitale – FMD

Organisation Name	*I.C. Rita Levi Montalcini*
Duration of the sessions	20/30 minutes
Number of sessions per students	2
Description of physical environment	Class regularly used by the students equipped with kinect, web camera, laptop, tablet, smartphone, IWB.
Description of social environment	1 technical assistant, 1 tutor, 1 teacher, 1 student for each session The teachers received tutor's training and assistance, but highlighted the need for more time before rehearsal and practice sessions in order to be able to use the system in an educational context. The system ensured data protection and parents, teachers and students were informed of the data collection a priori gathering informed assent.
Description of learning environment	At the I.C. Rita Levi Montalcini was the daily learning environment where the MaTHiSiS setting was organised for students to access one by one at the presence of the teacher and tutor. The students were part of the mainstream class participating in MEC. The environment was comfortable for the students but noisy as for the frequent movement of the students in the outside courtyard.
Teachers involved (number and subjects)	2 teachers (literacy, math, geography, history); 2 support teachers.
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	The age range of the 16 users was from 9 to 10 years old, all speaking Italian language only. They were all enrolled in the same school class, at 4th primary grade. 5 of them demonstrating different learning difficulties and behavioral disorders

Table 18: IC Rita Levi Montalcini School (Rome)

5.3.2.2 Polo Europeo della Conoscenza - PE

Organisation Name	*I.C. Leonardo da Vinci*
Period of the sessions	10 to 20 minutes
Number of sessions	1
Description of physical environment	Dedicated room with laptop, Nao robot, kinect, webcam, tablet, internet connection
Description of social environment	2 teachers, 12 pupils, 2 tutors
Description of learning environment	The pupils involved are 6 and 7 years old boys attending the first and the second grade of primary school. Other pupils from their same class participated to the mainstream use case Driver Pilot.

Teachers involved (number and subjects)	✓ 1 teacher (teaching humanities) with the help of the special need ✓ teacher (not directly involved in the project) ✓ -1 teacher (teaching maths and science) with the help of the special need teacher (not directly involved in the project)
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	✓ 6 pupils of first grade: 3 of them with learning difficulties and special educational needs, 1 potentially gifted ✓ 6 pupils of second grade: 3 of them with learning difficulties and special educational needs, ✓ 1 not diagnosed ASD

Table 19: I.C. Leonardo da Vinci, Bussolengo (VR)

Organisation Name	*I.C. Don L. Milani*
Period of the sessions	10 to 20 minutes
Number of sessions	1
Description of physical environment	Dedicated room with laptop, kinect, webcam, tablet, internet connection
Description of social environment	1 teacher, 2 students, 2 tutors
Description of learning environment	The students involved are 12 and 13 years old attending the middle school. They both have some learning and behavioural difficulties
Teachers involved (number and subjects)	1 teacher (teaching maths and science) with the help of the special need teacher (not directly involved in the project
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	✓ 13 years old girl with mild cognitive delay, specific learning difficulties ✓ 12 years old boy with mild cognitive delay, specific learning difficulties, mild motor difficulties

Table 20: I.C. Don L. Milani, Sommacampagna (VR)

5.3.2.3 LA Cometa del Sud – LCS

Organisation	*I° Circolo Didattico di Cava De' Tirreni*
Period of the sessions	40 minutes
Number of sessions	4 (1 each student)
Description of physical environment	Dedicated room with Hi-tech LAB with laptop, kinect, webcam, tablet, internet connection
Description of social environment	3 tutors, 3 teachers, 7 students in a friendly and available context of a school which is better than the local average from the organizational

	point of view
Description of learning environment	The students involved are between 6 and 10 years of age. The learning environment to achieve the goals is based on the constructive relationship between the teacher and the child, have been encouraged to carry out an independent activity. The teacher's ability was to stimulate motivation and commitment, Encourage collaborative learning
Teachers involved (number and subjects)	2 specialist support
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	7 students, 1 aged 6 with a good schooling, highly interested in art, 2 aged 7 with a good schooling, extroverted and very sensitive performance, 2 aged 8 and 2 aged 10 With sufficient scholastic performance, very lively and interested in new technologies and also very curious in general.

Table 21: Primo Circolo didattico di Cava de' Tirreni (SA)

5.3.3 Spain

5.3.3.1 Consejería de Educación – Junta de Castilla y León - JCYL

Organisation Name	*CEIP "Miguel de Cervantes"*
Period of the sessions	20-25 minutes
Number of sessions	1 session for each pupil
Description of physical environment	Dedicated room with laptop, kinect, webcam, nao robot, tablet and good internet connection
Description of social environment	2 teacher (1 infant school teacher and 1 teaching maths) 2 tutors 1 technician (from the consortium)
Description of learning environment	2 children 4 years old and 4 children from the 5th grade primary school (10 years old)
Teachers involved (number and subjects)	2 (1 infant school teacher and 1 teaching mathematics)
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	5- 10 years old ME ((3 male, 2 female) with no learning difficulties 2- 4 y.o. ME (2 female) with no learning difficulties

Table 22: CEIP "Miguel de Cervantes", Valladolid

5.4 Learning goals, Smart Learning Atoms, Learning Materials

5.4.1 Learning goals, Smart Learning Atoms

5.4.1.1 UK

Nottingham Trent University - NTU

Learning goals, SLAs and Learning Actions		
Age 11-18		
Learning Goal	**SLA**	**Learning Action**

Write spreadsheet formula	Learn the format of a formula	Experiment with the relationship of the syntax and outcome of a formula in a spreadsheet
Write spreadsheet formula	Learn the syntax of a formula	
Work with a spreadsheet formula	Learn how a spreadsheet formula can automate calculations and change a spreadsheet	Experiment with a spreadsheet formula that changes cells after input is entered
Work with a spreadsheet formula	Use a spreadsheet formula to perform automated calculations	
Write a spreadsheet formula to auto simple calculations	Learn how to use a spreadsheet formula to automate simple calculations	Experiment with a spreadsheet formula that changes cells after input is entered
Write a spreadsheet formula to auto simple calculations		

Table 23: Notthingam Bluecoat academy

5.4.1.2 Italy

Fondazione Mondo Digitale – FMD

Learning goals, SLAs and Learning Actions		
Age 9-10		
Learning Goal	**SLA**	**Learning Action**
Enhance Motor Skills	Motor sequencing and spatial coordination	Repeat/imitate a sequence
Enhance Motor Skills	Improve motor coordination (arm and leg coordination, hand-eye coordination)	Hand eye coordination, spatial perception
Cognitive skills	Improve literacy	Compose words/sentences
		Combine picture and word
	Improve language comprehension	Visualise the content
		Make connections
	Improve Maths skills	Number Quantity correspondence
		Discrimination of greater than /less than
		Put numbers in order (ascending/descending)
Communication/ Socialisation Skills	Express feelings	Engage in a dialogue
		Recognise emotions
	Social perspective taking	Engage in a dialogue

Learning goals, SLAs and Learning Actions		
		Recognise emotions

Table 24: I.C. Rita Levi Montalcini (Rome)

Polo Europeo della Conoscenza – PE

Learning goals, SLAs and Learning Actions		
Age 9-10		
Learning Goal	**SLA**	**Learning Action**
Enhance Motor Skills	Motor sequencing and spatial coordination	Repeat/imitate a sequence
Enhance Motor Skills	Improve motor coordination (arm and leg coordination, hand-eye coordination)	Hand eye coordination, spatial perception
Cognitive skills	Improve literacy	Compose words/sentences
		Combine picture and word
	Improve language comprehension	Visualise the content
		Make connections
	Improve Maths skills	Number Quantity correspondence
		Discrimination of greater than /less than
		Put numbers in order (ascending/descending)
Communication/ Socialisation Skills	Express feelings	Engage in a dialogue
		Recognise emotions
	Social perspective taking	Engage in a dialogue
		Recognise emotions

Table 25: I.C. Leonardo da Vinci - Bussolengo (VR)

Learning goals, SLAs and Learning Actions		
Age 12-13		
Learning Goal	SLA	Learning Action
Improve attention skills	Improve attention skills	Reproduce a sequence of pictures / sounds

Improve social skills	Basic emotion recognition	Say emotions
		Classify emotions
	Emotional awareness	Identify emotional facial expressions
		Demonstrate understanding of different emotions

Table 26: Istituto Comprensivo Don Milani (Sommacampagna)

La Cometa del Sud - LCS

Learning goals, SLAs and Learning Actions		
Age 6-10 years old		
Learning Goal	SLA	Learning Action
Improve literacy	Combine picture and word	Combine the image with the corresponding word
Motor sequencing and spatial coordination	Make an image through puzzle	Building a puzzle with growing difficulty increasing the number of tiles
	Repeat/imitate a sequence	Repeat and imitate images that run on the screen
Improve language comprehension	Awareness of the name of the objects represented	Associate the corresponding word with each object
	Awareness of the meaning of wo and cognitive abilities	Determine what objects have in common

Table 27: Primo Circolo Cava De' Tirreni (SA)

5.4.1.3 Spain

Consejería de Educación – Junta de Castilla y León - JCYL

Learning goals, SLAs and Learning Actions		
Age: 10- 11 years old		
Learning Goal	SLA	Learning Action
Improve attention skills	Visual attention	Look at pictures for a time
		Visually track pictures (focusing)
	Hearing attention	Hearing a sound for a time.
Improve Language Skills	Synonyms / antonyms	Find synonyms
		Find antonyms
	Semantic fields establishment (conceptual networks)	Connect words about one semantic field

Learning goals, SLAs and Learning Actions		
Improve Maths skills	Number Quantity correspondence	Associate a number with a quantity
	Discrimination of greater than/less than	Put numbers in order (ascending/descending)
		Identify the largest / smallest number between two numbers
Improve social skills	Emotional awareness	Identify emotional facial expressions
		Demonstrate understanding of different emotions
	Eye contact	Make eye contact with an animated target.
		Make eye contact with different facial expression

Table 28: CEIP Miguel de Cervantes

5.4.2 Learning Materials

5.4.2.1 UK

At the Trinity Catholic School the PAs used were laptops and PCs compliant with the proposed SLAs and LGs. The following LMs were developed to be used during Driver Pilots:

- LA to determine observe different python code programming syntax outcomes
- LA to Identify the subject which is the 'murderer' using spreadsheet logic
- LA to Understand 'Selection' in a spreadsheet usage context
- LA to write a python code as part of the learning material example
- LA to developing code as part of the learning material example
- LA to develop a quiz in python using a variable
- LA to add an 'option' within a 'selection'
- LA to observe the outcome of some small variance in examples of python code syntax for the same command, and then to execution of that code

At the Bluecoat Academy the PAs used were laptops and PCs compliant with the proposed SLAs and LGs. The following LMs were developed to be used during Driver Pilots:

- LA to write a spreadsheet formula
- LA to work with a spreadsheet formula
- LA to write a spreadsheet formula to automate simple calculations
- LA to read the Learning Objectives of the spreadsheet learning activity
- LA to answer questions in relation to the spreadsheet learning material
- LA to list three things you have learnt in relation to the spreadsheet learning material

5.4.2.2 Italy

Fondazione Mondo Digitale – FMD

At the I.C Rita Levi Montalcini the PAs used were smartphone and tablets compliant with the proposed SLAs and LGs. The following LMs were developed to be used during Driver Pilots:

- LA demonstrates understanding of different emotions: The app in the tablet show three different pictures of people and define the emotion they are showing. After that only one picture is showed and the pupil has to select the correct emotion.

- LA puts numbers in order (ascending/descending) The app in the tablet requires to put three numbers in ascending or descending order.
- LA counts the pictures: the app in the tablet requires to put choose among 3 numbers that corresponding to the number of pictures on the screen.
- LA associates a number with a quantity: The app in the tablet display a number of dots and the pupil has to answer how many they are.
- LA Identifies emotional facial expressions: The app in the tablet show different pictures and ask the pupil to identify the correspondent emotion (neutral, angry, happy, sad, disgusted, scared).
- LA associated with improving language comprehension making connections: The App in the tablet displays 2 pictures of different objects and 3 words, requires the pupil to identify the word corresponding to the element that the objectives have in common.
- LA associated with improving literacy making connections: The app in the tablet displays 3 pictures of objects and the corresponding words. It asks the pupils to match pictures and words.
- LA associated with improving literacy making connections: The App in the tablet displays 3 pictures and 1 word and ask the pupil to match the word with the picture.
- LA associated with improving literacy making connections: The app in the tablet displays 3 pictures and one letter of the alphabet and asks the pupil to select the picture of the word initiating with the letter displayed.
- LA associated with improved math understanding number quantity correspondence: The app in the tablet displays 4 pictures of a number of objects and 4 numbers. The pupil is required to match the numbers with the pictures.
- LA associated with improve hand-eye coordination: The app displays a piano keyboard sequence an ask the pupil to repeat it.
- LA associated with improve hand-eye coordination: The app displays a monster and some biscuits, the pupil is asked to move the biscuits on the screen so to let the monster eat them.
- LA associated with improving literacy: The app displays a picture and the pupil is asked to write the corresponding word.
- LA associated with improve hand-eye coordination: pieces of a picture are showed on the tablet screen and the pupil is asked to compose the picture.
- LA associated with improve motor coordination discriminating left and right: The App displays 2 pictures and asks the pupil to select that on the right on the left.
- LA associated with improve hand-eye coordination: The app displays a labyrinth and asks the pupil to complete it.
- LA associated with improve math: the app displays 2 numbers and asks the pupil to select the higher number.

Polo Europeo della conoscenza – PE

At the I.C Leonardo da Vinci Bussolengo the PA used are tablets with the same LM of FMD and Nao robot with the following LMs:

- LA repeats/imitates gesture: The NAO robot performs some movement and asks the children to repeat the sequence of gestures.
- LA finds synonyms: The NAO robot asks to identify the synonym of a word among the suggested ones.
- LA finds antonyms: The NAO robot asks to identify the antonym of a word among the suggested ones.
- LA connects words about one semantic field: The NAO robot which asks to pronounce a word linked to a given topic.
- LA identifies emotional facial expressions: The NAO robot asks the pupil to identify and show one emotion (neutral, angry, happy, sad, disgusted, scared).

At the I.C. Don L. Milani, Sommacampagna, the PA used is the tablet:

- LA Identifies emotional facial expressions: The NAO robot ask the pupil to identify and show one emotion (neutral, angry, happy, sad, disgusted, scared).
- LA demonstrates understanding of different emotions: The app in the tablet show three different pictures of people and define the emotion they are showing. After that only one picture is displayed and the pupil has to select the correct emotion.

LCS_Primary School I Circolo Cava De Tirreni

- LA combines picture and work_ The tablet provides an image on the screen and the words written below, usually 3, and the child must associate the image with the exact word, for example: image of a dog and in words the word dog.
- LA makes an image through puzzle_ The child has to build a jigsaw puzzle with four confusing weasels and must be able to put them in the right way to make an imagine than he/she passes from a jigsaw puzzle of four tiles to a more difficult level by increasing the number of tiles.
- LA repeats/imitates a sequence_ LA Identifies emotional facial expressions: The app in the tablet shows different pictures and asks the pupil to identify the correspondent emotion (neutral, angry, happy, sad, disgusted, scared).
- LA: Awareness of the name of the objects represented_ LA associated with improving literacy: The app displays a picture and the pupil is asked to write the corresponding word.
- LA: Awareness of the meaning of words and cognitive abilities_ The tablet provides two different images between them and underneath them other images, one can find out what the two images above have in common and click on the right image.

5.4.2.3 Spain

Consejería de Educación, Junta de Castilla y León –JCYL

At CEIP “Miguel de Cervantes” the PA used were tablets and Nao robot with the following LM:

- Count pictures: the app in the tablet requires to choose among 3 numbers that corresponding to the number of pictures on the screen.
- LA associates a number with a quantity: The app in the tablet display a number of draws and the pupil has to answer how many they are.
- LA finds synonyms: NAO robot asks to identify the synonym of a word among the suggested ones.
- LA finds antonyms: NAO robot asks to identify the antonym of a word among the suggested ones.
- LA connects words about one semantic field: The NAO robot asks student to pronounce a word linked to a given topic (home, school, hospital…).
- LA Identifies emotional facial expressions: The NAO robot asks the pupil to identify and show one emotion (neutral, angry, happy, sad, disgusted, scared).
- LA identifies a sound that corresponds to an emotion (laugh, crying, etc): The NAO robot cries or laughs and asks pupil which emotions it is.

6 Comments and general remarks

6.1 Teachers perspective

6.1.1 UK

6.1.1.1 Nottingham Trent University - NTU

Due to the changes with the starting dates, initial training with teachers had to be cancelled. Teachers therefore sent their learning materials to the research team at Nottingham Trent University who created the Learning Graphs.

It is intended that, once the system is available on a PC, the common platform for schools in the UK, intensive training will be carried out with all teachers. A schedule for this is currently being planned and will be timed for October, prior to the Assisted Pilot stage.

Materials that were sent through were for full teaching groups of 30 by the teachers on a weekly basis. The limitation of PA to laptop resulted in data only being collected from 2 students in each session.

Teachers were concerned that the transition of materials was not available. This caused difficulties in integration of the platform into mainstream classrooms. This has been reported and assurances given that this will be available for the future pilots.

Teachers are supportive of the system and future developments but it must work for whole groups, not 2 children working on their own.

6.1.2 Italy

6.1.2.1 Fondazione Mondo Digitale – FMD

Teachers involved in the Driver Pilots' implementation in Rome demonstrated a collaborative and positive attitude during all the sessions, despite the interruptions caused by the technical difficulties. They contributed to inform and prepare students, other teachers/psychologists and school personnel involved in the different phases of the Driver Pilots (system and equipment set up, setting preparation, sessions scheduling and implementation). Teachers' main expectations were related to the system's integration with the school's environment, curriculum and daily routine.

As it was planned in the driver pilots, side-by-side support from the tutors was required regarding the system's set up and management during the sessions with students. Teachers and psychologists of both the venues generally approached MaTHiSiS with a solicitous interest, posing questions about its functions and potential. They were aware of the experimental value of the Driver Pilots and provide several feedbacks and opinions during the sessions' implementation that can be summarized as follows:

- MaTHiSiS can potentially provide teachers/psychologists with an additional tool to evaluate students' affect states, particularly of those students with some learning difficulties.
- Affect state recognition represents a different approach to teaching, specifically in public schools, introducing the affective sphere as an active element of learning processes.
- MaTHiSiS fosters the use of ICTs in teaching, seen not only as leisure, but also with a pedagogical value, due to the possibility of programming and defining goals and skills to be achieved.

Some criticalities were also highlighted, mainly related to the technical issues of the system not already mature enough to be easily applied in a pedagogical environment to support students learning experience:

- MaTHiSiS can be a support for teaching and learning in mainstream contexts if the technical issues are reduced and the time for technical management does not affect the time teachers have to allocate on pedagogy.
- The system use cannot require high level of technical abilities as teachers do not have such skills and technical assistance is not provided by the school.
- PAs and LMs have to run efficiently and be adequate to students' curriculum in order for the system to be embedded in the daily activities of the classroom.

6.1.2.2 Polo Europeo della Conoscenza - PE

Despite the specific training given to them, even the teachers more used to the ICT needed a side by side support due to the set up of the system and to the different devices involved in the test. One of their feedbacks for the next phases of development of the platform is to make this phase easier, because the technical staff of the schools is not always available to help the teachers.

About the learning experience the teachers reacted positively to the structure and were very interested by the future use of MaTHiSiS system.

6.1.2.3 La Cometa del Sud - LCS

Teachers involved in pilots' implementation have taken a collaborative and perceptive attitude throughout the implementation sessions, showing interest in future feedbacks as well.

They also contribute to organize the students according their schedules and activities and provide significant support in all phases of pilots.

The establishment and management of the system required the tutor to have an initial support that it was needed to improve it from a session to the next one mostly for technical reasons.

6.1.3 Spain

6.1.3.1 Consejería de Educación. Junta de Castilla y León- JCYL

Teachers and psychologist involved in the pilots have worked very actively with the JCYL team during all phases, since the creation of learning graphs until the execution of the pilots.

Teachers and psychologist were used to work with ICT for pedagogical purposes as there are network of centres that train them since more than 15 years. Nevertheless, the driver pilots could be only run with the presence and the on-site support of the MaTHiSiS technical partners.

With regards to the learning experience, the teachers were really enthusiastic about the possibilities of the platform if the user friendliness and the ability to detect the learner's affect are improved.

The different devices (tablets and Nao robot during driver pilots) were not adapted to different levels of difficulty: the LG was the same for 4-5 years old and 10-11 years old changing the level of difficulty and it was too easy for 10-11 years old. According to the teachers passive sensors did not interpret correctly the engagement, boredom or frustration of the learner.

Rewards on both devices should be improved. When the activity is well done neither the NAO robot nor the tablet show good enough feedback for children.

6.2 Learners perspective

6.2.1 UK

6.2.1.1 Nottingham Trent University - NTU

The students worked through the same lesson materials as the rest of the class (class size 30) but with data being collected of their affective state. Students were therefore not working any differently through using the system.

The project was discussed with mainstream students, who were interested in the potential of the platform.

Difficulties were encountered by students as they were not able to translate their learning materials. The students were very co-operative with the challenges of the system in this pilot stage.

6.2.2 Italy

6.2.2.1 Fondazione Mondo Digitale - FMD

Mainstream students involved in the Driver Pilots in Rome approached MaTHiSiS Driver Pilots with curiosity and engagement, aware that they were taking part in a research project requiring their active contribution in the experimentation phase.

All students were interviewed at the end of the sessions in order to gather their feedback. They found the overall experience enjoyable but highlighted the need for a more mature learning experience including different learning materials related to their daily learning. Some of them found the learning materials too easy, different levels of difficulty should be available. Some of them expressed the willing to use MaTHiSiS with the other students, in class, to work collaboratively. They also reported some correspondence between their state of affect and that detected by MaTHiSiS.

Students were not able to use the subsystem independently, support by tutors and teachers were constantly provided during the sessions, to manage the technical issues raising during the sessions.

6.2.2.2 Polo Europeo della Conoscenza - PE

The teachers introduced the new setting and devices to the children, for those who worked with the Nao Robot the first time, their reaction was very positive. The teachers proposed some minor changes in the Learning Materials (mainly on the reward mechanism and the levels of difficulty) to make them more suitable for the learners.

6.2.2.3 La Cometa del Sud - LCS

MEC children are children aged 6 to 10 years and have a good schooling. They are attracted to the technology because they know very well the use of the tablets even if some of them are still very small. Because of this they worked with a lot of enthusiasm in using this new learning method and in working with their special needs friends.

They all reached the learning objective and there were no difficulty to make the pilots functioning after the technical problems were solved and they will fully test the session.

The establishment and management of the system required the tutor to have an initial support that it was needed to improve it from a session to the next one mostly for technical reasons.

6.2.3 Spain

6.2.3.1 Consejería de Educación, Junta de Castilla y León

Pupils were interesting on the work with tablets and the Nao Robot. Levels of difficulty were not adapted to all cases (it was fine for 4-5 years old and therefore too easy for 10-11 years old pupils).

Sometimes learners were not really aware whether they succeed or not as the rewards were not clear/ strong enough for them.

7 Evaluation of the system

7.1 Objective

The objective of the evaluation is to collect feedback from the end-users of the MaTHiSiS platform in order to assess the user experience aspects. The results of the evaluation will be used at the second cycle of the development to improve the MaTHiSiS platform for the assisted phase of the pilots.

7.2 Approach

A first round of evaluation activities were conducted in parallel with the driver pilots' sessions. The evaluation approach is based on the framework defined in "D2.5 Evaluation Strategy"[7]. Based on the KPIs which were defined to measure the use and satisfaction of the users of the MaTHiSiS platform and evaluate the suitability of the services provided by MaTHiSiS, the evaluation questions were created and included in D2.5.

Before the driver pilots took place, the questions were reviewed by the pilot partners, who provided feedback about feasibility (for this piloting phase), suitability, usefulness, etc., per their particular learning settings. To this end, some of the questions were redesigned or excluded based on the feedback gathered, for this piloting phase (e.g. due to feasibility: the particular set-up of this piloting phase did not allow for the evaluation of particular aspects in the questions), or in general (e.g. due to suitability/usefulness: for the particular types of learners or the in particular learning setting some questions did not make sense/were not deemed useful).

The questionnaires were deployed in Qualitrics, an online tool for surveys and the links were distributed to the pilot partners of the consortium in order to provide the evaluation results. The pilot partners circulated the online questionnaire links to the teachers and learners, who filled in the questionnaires during the driver pilot sessions. The poll can be found here: http://bit.ly/mecdriverpilot.

It is worth mentioning that for the driver pilots, the MaTHiSiS consortium decided on the full deployment of the technical set-up, i.e. creation of Learning Experiences, ingestions of user, Platform Agent (PA) and Learning Material (LM) attributes by the technical partners, and on full support of users (teachers and learners) on-site for every step of the process. This decision was opted in order to facilitate the users with the use of brand new technologies based on tangible exemplification of the process. Consequently, the level of external support during the driver pilots was purposefully very high, with the aim that this process will a) facilitate the introduction of the new proposed educational setting and b) boost the process of independent use of the platform in the next two piloting phase.

7.3 Stakeholders

The following stakeholders were invited to fill in the evaluation questionnaires:

7.3.1 Teachers / Tutors / Observers

The total number of answers to the survey from this group of stakeholders is 51. 34 out of 51 answers were from observers, that is, people from the MaTHiSiS consortium who went in and ran the driver pilot sessions.

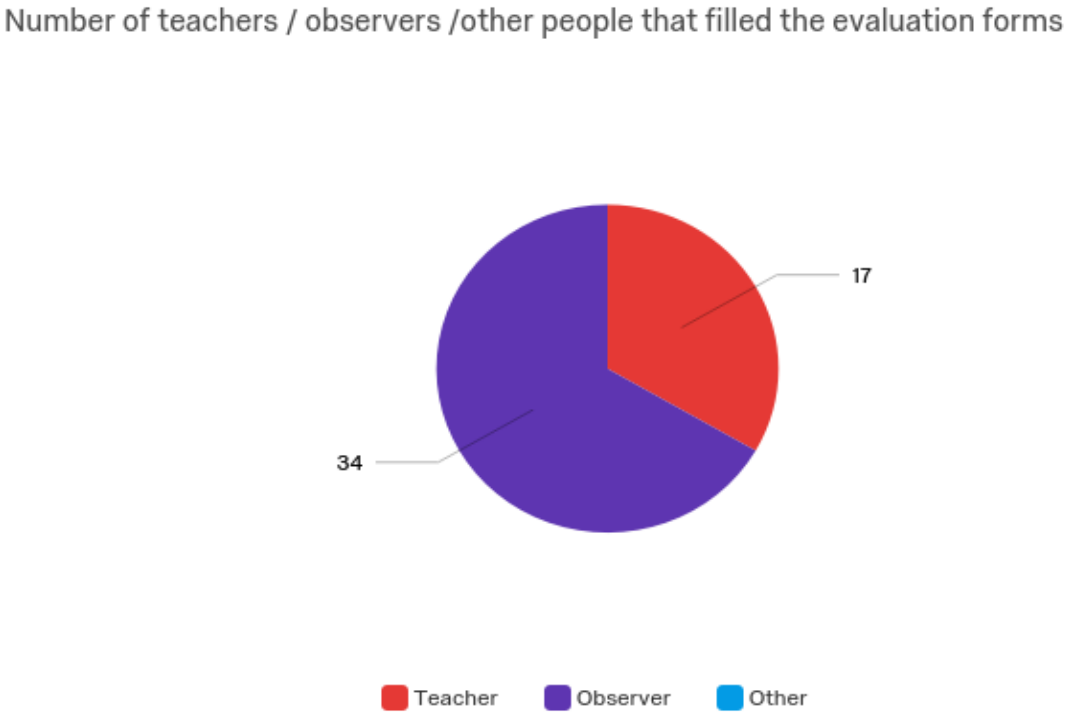

Figure 1: Stakeholders - Teachers / Tutors / Observers

7.3.2 Learners

The number of respondents to the survey from the student's perspective was 51. Most of them were teachers or observers that replied on behalf of the learners as in most of the cases they were unable to answer the questions.

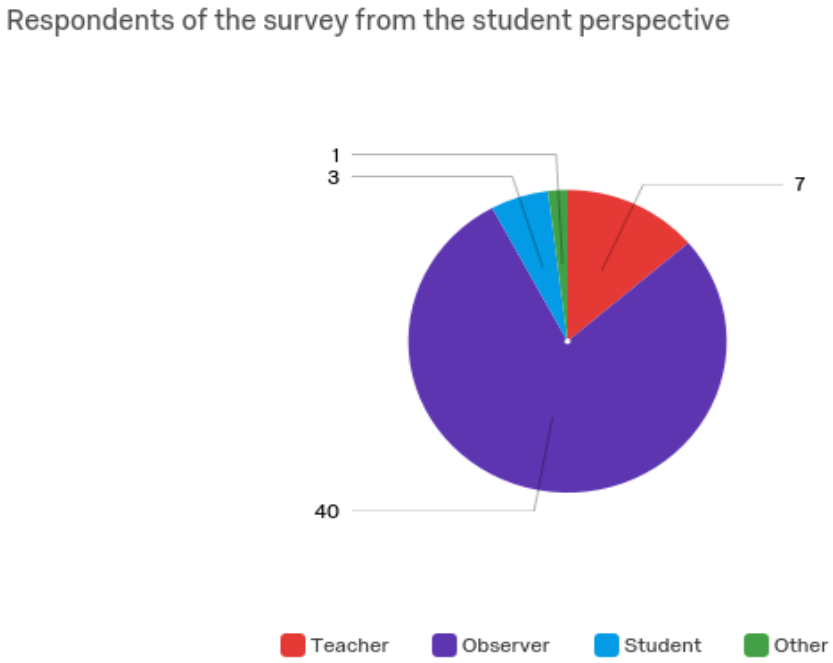

Figure 2: Stakeholders – Learners

7.4 Results

In this section the evaluation results for each KPI from D2.5 is presented and analysed. The usability, reusability and accessibility KPIs have been evaluated from the teacher and learner perspective. The existing Qualitrics analysis tools have been used to display graphs and analyse the data.

7.4.1 KPI#1 Usability

KPI#1 for usability measures the quality of fit (of MaTHiSiS) in the educational purpose it set out to serve, i.e. to re-define current learning practices into highly individualized and adaptive, goal-oriented learning, while at the same serve pedagogical purposes and facilitate traditional educational structures. Also, from a user experience point, it measures the quality of users (trainee or trainers) to actively see MaTHiSiS as a useful and functional tool.

TEACHERS

Questions

In order to measure this KPI, the questions below were asked. The numbers in the pie charts indicate the number of teachers that voted for each answer.

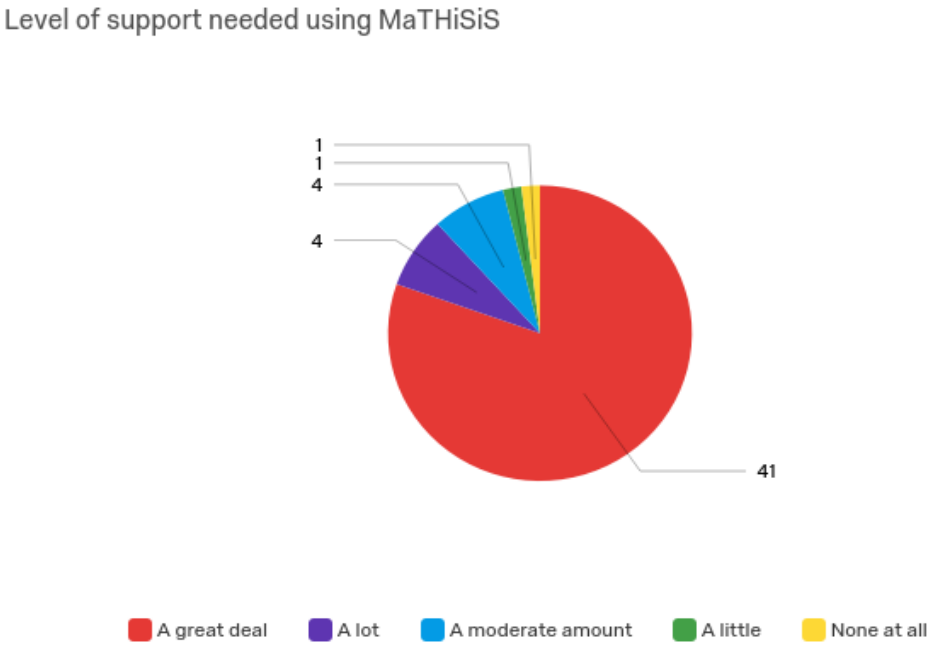

Figure 3: KPI 1 Usability: Teachers' perspective - Question 1

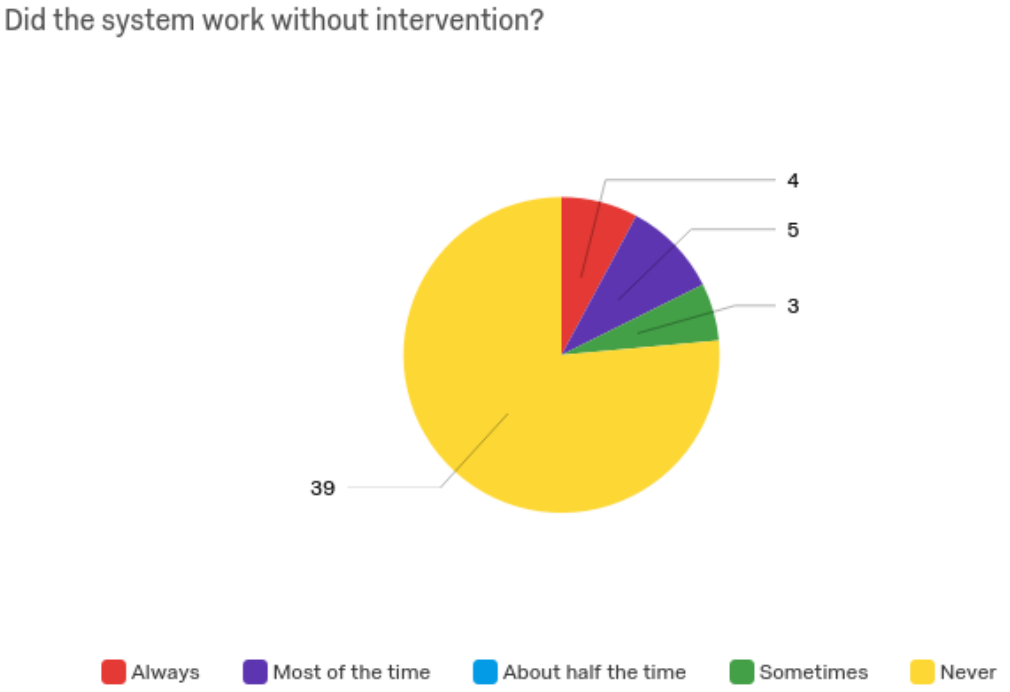

Figure 4: KPI 1 Usability: Teachers' perspective - Question 2

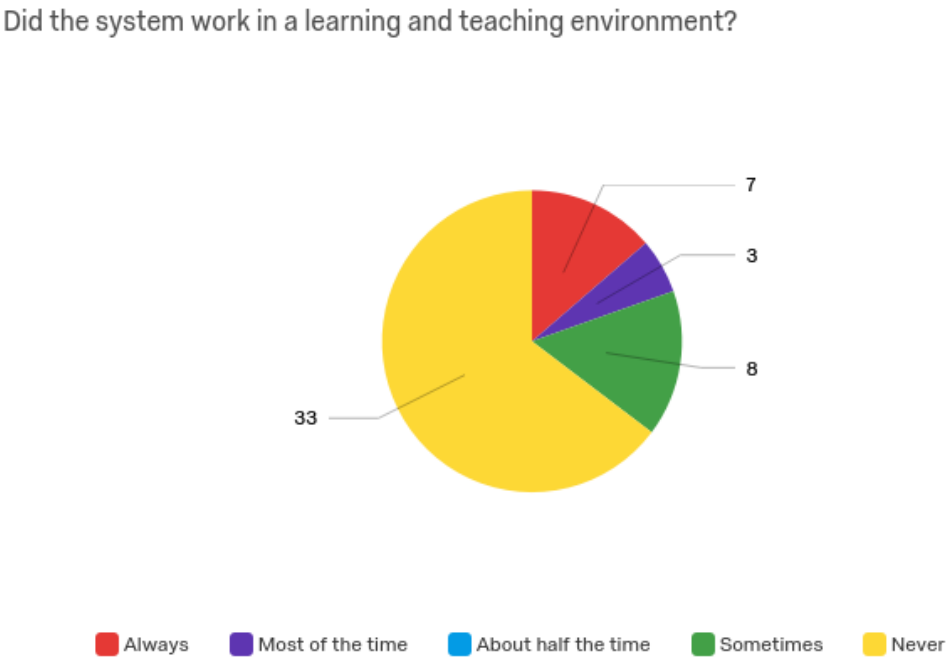

Figure 5: KPI 1 Usability: Teachers' perspective - Question 3

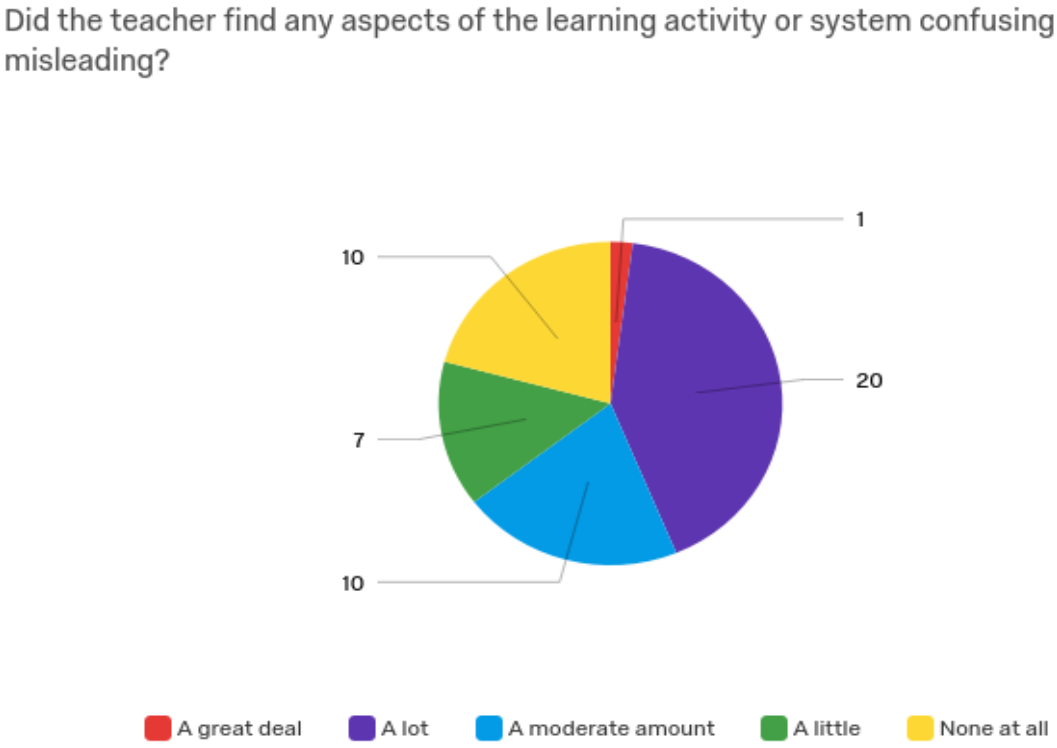

Figure 6: KPI 1 Usability: Teachers' perspective - Question 4

Conclusions

Most of the teachers needed the support from the MaTHiSiS partners to run the platform, which is in line with the design and set-up of driver phase of the pilots, as mentioned in the Approach section, with piloting partners actively assisting at a substantial part of the Learning Experience, as expected. In the next phase of the pilots ("assisted") the platform will be run by the teachers with the assistance from the MaTHiSiS partners, while by the final ("real-life") phase, it is expected that the teachers will be able to run the system with little to no assistance/intervention.

With regards to the question about the "working of the system in a learning environment", more than half of the respondents replied that the system did not work well as, in some cases, it was not possible to execute a complete learning experience process, due to technical problems presented in the first version of the platform and/or misalignments in the set-up of the Learning Experience. For example, as explained in Deliverable D4.2 MaTHiSiS Sensorial Component, it was observed that more detailed training is needed in the set-up of sensors (e.g. cameras facing the learner, with the face and/or body of the learners inside the field of view, reduction of ambient noise, etc.), which is inherent for the reliable use of the MaTHiSiS system. The substantial and intrinsic use of sensors such as cameras, microphones and inertial sensors is a very novel and unfamiliar territory in traditional educational settings and it is expected that most of the familiarization effort during the course of the project will be focused on this point.

There is also the need to improve the user-friendliness of the platform as almost half of the participants had found different aspects of the MaTHiSiS-induced learning process and the platform misleading or confusing.

The driver pilots were designed with the purpose of providing important, baseline, information about the technical, human-computer interaction (HCI) and pedagogical usability of the MaTHiSiS approach. And through the testing that occurred in the first version of the platform, the MaTHiSiS consortium was able to extract extremely valuable insights about how the MaTHiSiS concept works in different settings, in all the aforementioned aspects. The driver pilots have allowed to identify important matters that could not have been known but for piloting in real-world settings. Therefore,

important aspects that will improve the stability, the HCI protocol and the pedagogical value of MaTHiSiS have already started being improved for the assisted phase of the pilots.

LEARNERS

Questions

In order to measure this KPI, the questions below were asked. The numbers in the pie charts indicate the number of learners that voted for each answer.

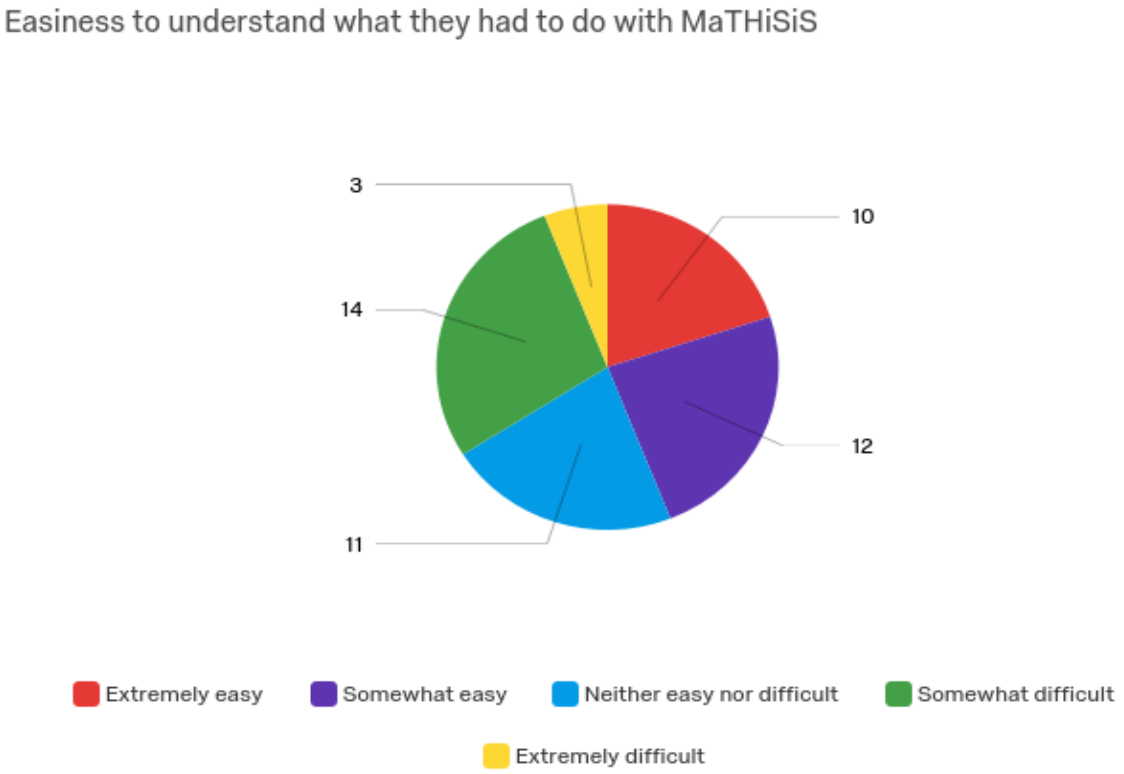

Figure 7: KPI 1 Usability: Learners' perspective - Question 1

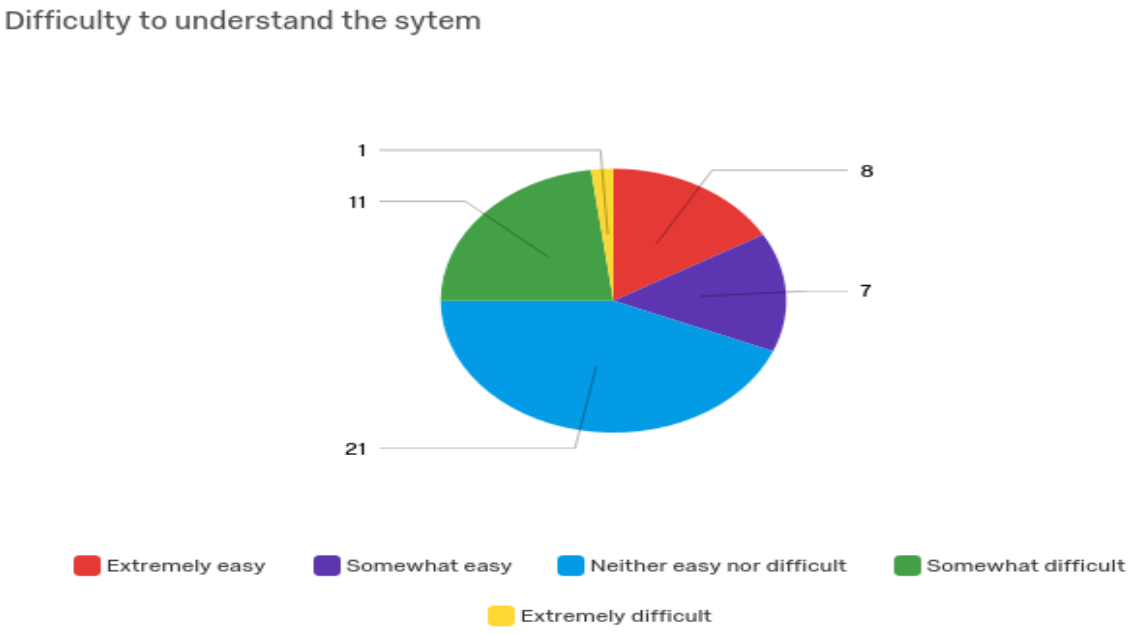

Figure 8: KPI 1 Usability: Learners' perspective - Question 2

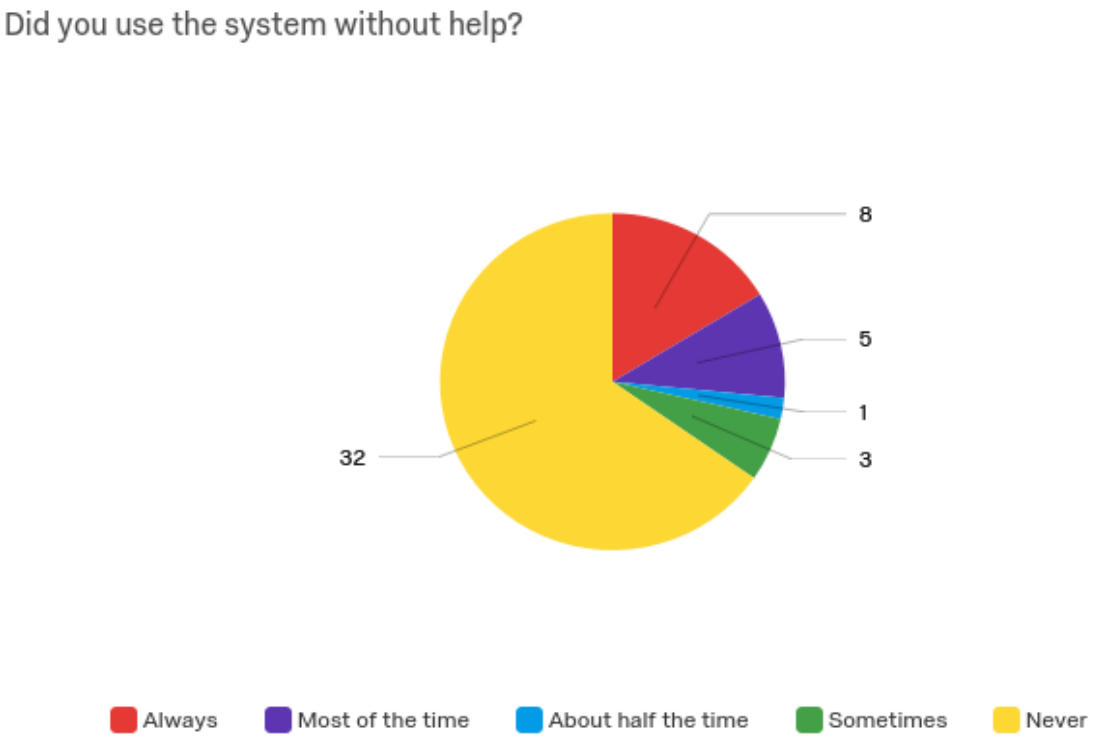

Figure 9: KPI 1 Usability: Learners' perspective - Question 3

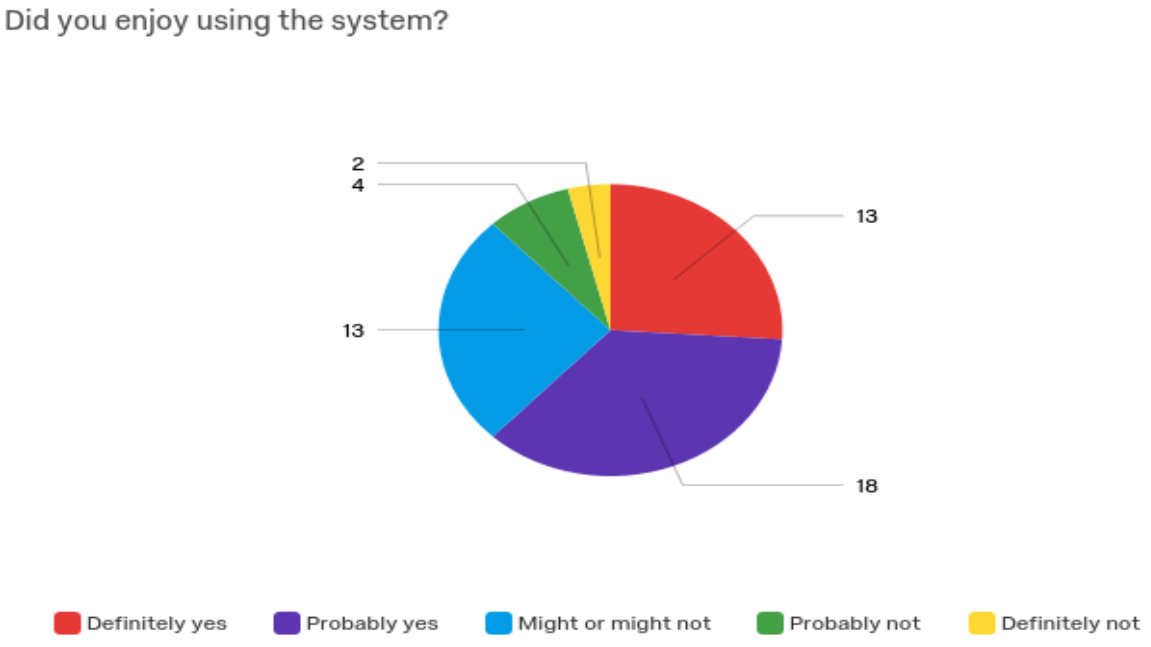

Figure 10: KPI 1 Usability: Learners' perspective - Question 4

Figure 11: KPI 1 Usability: Learners' perspective - Question 5

Conclusions

In this first version of the platform, the ease of use of this novel educational setting and the assumed complexity of using highly technology-based Learning Process facilitators was the most ambiguous and important aspect for which feedback was sought after. It is significant that, according to the responses, the majority of the learners understood what they had to do with the system and found the interaction with it very pleasant. As expected, the need for external help was imminent, and the technical difficulties and set-up alignment mentioned in the previous section prevented the learners from completing the learning experience process, thus achieving their personal goals. Finally, for the next piloting phases, the evaluators will seek to assess separately the achievement of personal goals and the level of individualization of the platform, since the criteria of measurement of these two facets are inherently different.

7.4.2 KPI#2 Reusability

KPI#2 for reusability measures the capacity and quality of the MaTHiSiS approach to uphold reusable learning structures, especially so in terms of the primordial learning elements that it introduces, i.e. the Smart Learning Atoms (SLAs). Reusability is supported by all learning content structures in MaTHiSiS (i.e. Learning Graphs, SLAs) as well as by the high-level conceptualisations of learning activities (i.e. the Learning Actions), however the core of the MaTHiSiS approach lies in the reusability of SLAs, therefore that is where the first round of input from the users was focused on.

TEACHERS

Questions

In order to measure this KPI, the questions below were asked. The numbers in the pie charts indicate the number of teachers that voted for each answer.

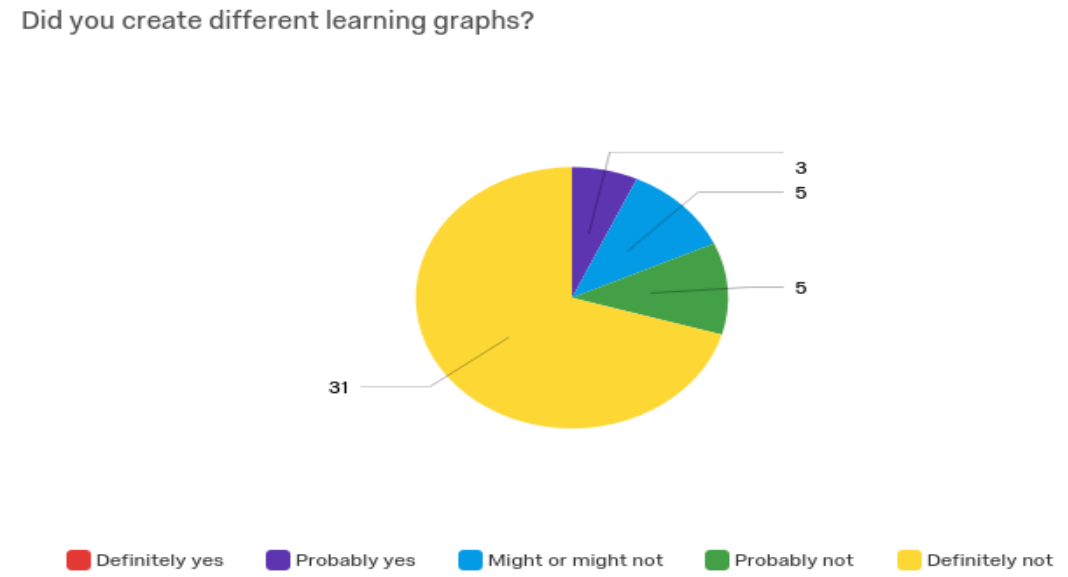

Figure 12: KPI 2 Reusability: Teachers' perspective – Question 1

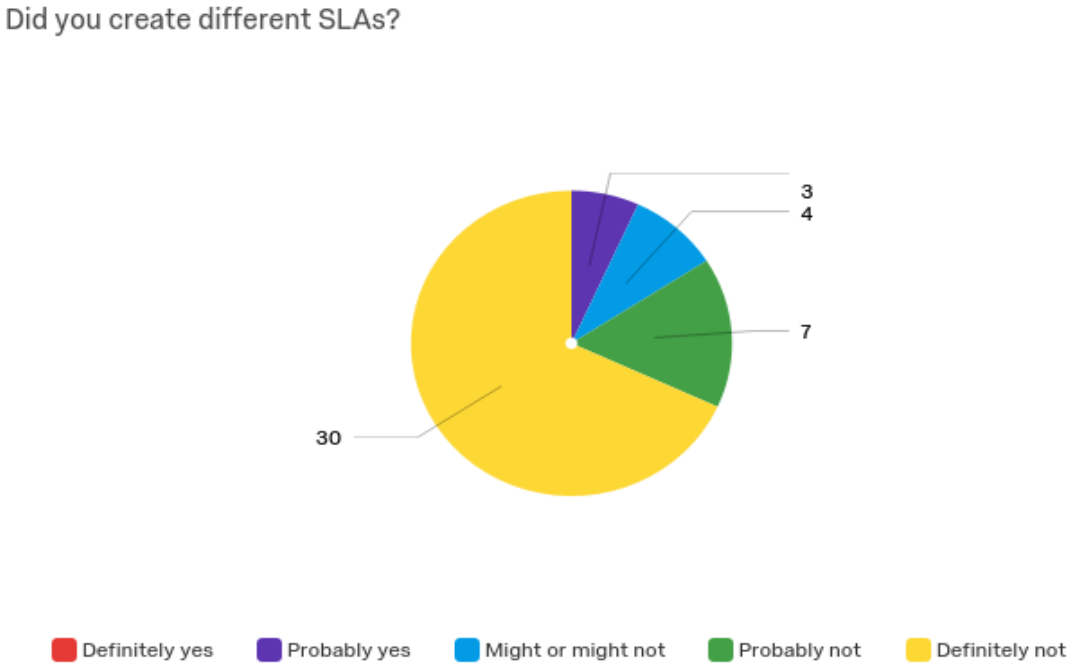

Figure 13: KPI 2 Reusability: Teachers' perspective – Question 2

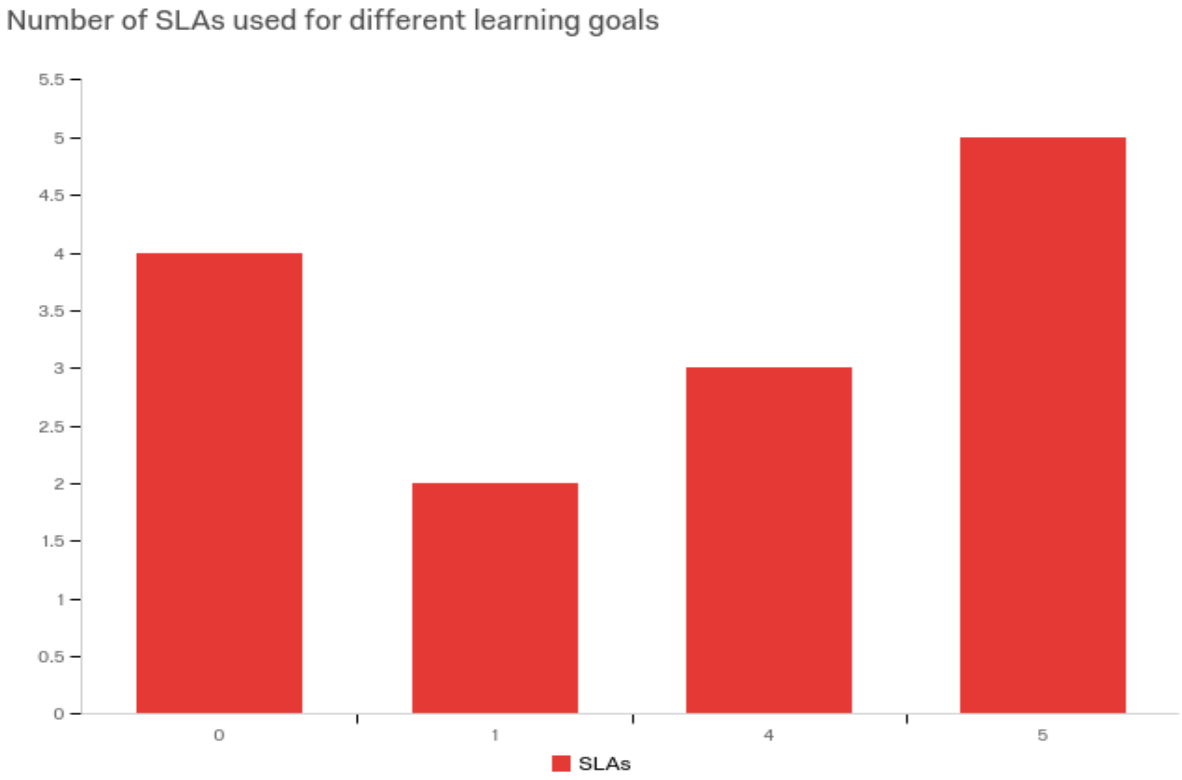

Figure 14: KPI 2 Reusability: Teachers' perspective – Question 3

The X axis indicates the number of SLAs used for different learning goals. The Y axis indicates the number of teachers that use SLAs for different learning goals. According to the graph, 5 teachers used 5 SLAs, 3 teachers used 4 SLAs, 2 teachers used 1 SLA and 4 teachers do not use SLAs for different learning goals.

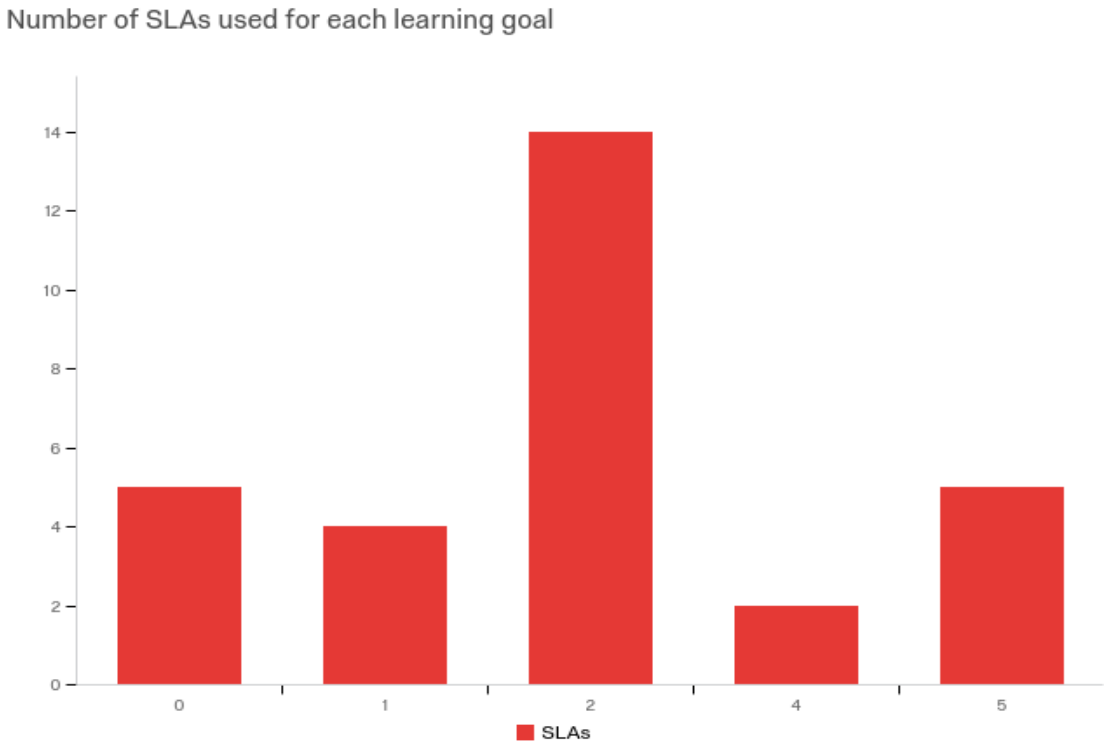

Figure 15: KPI 2 Reusability: Teachers' perspective – Question 4

The X axis indicates the number of SLAs used for each learning goal. The Y axis indicates the number

of teachers that use SLAs for each learning goal. According to the graph, 5 teachers used 5 SLAs, 2 teachers used 4 SLAs, 14 teachers used 2 SLAs and 4 teachers use one SLA.

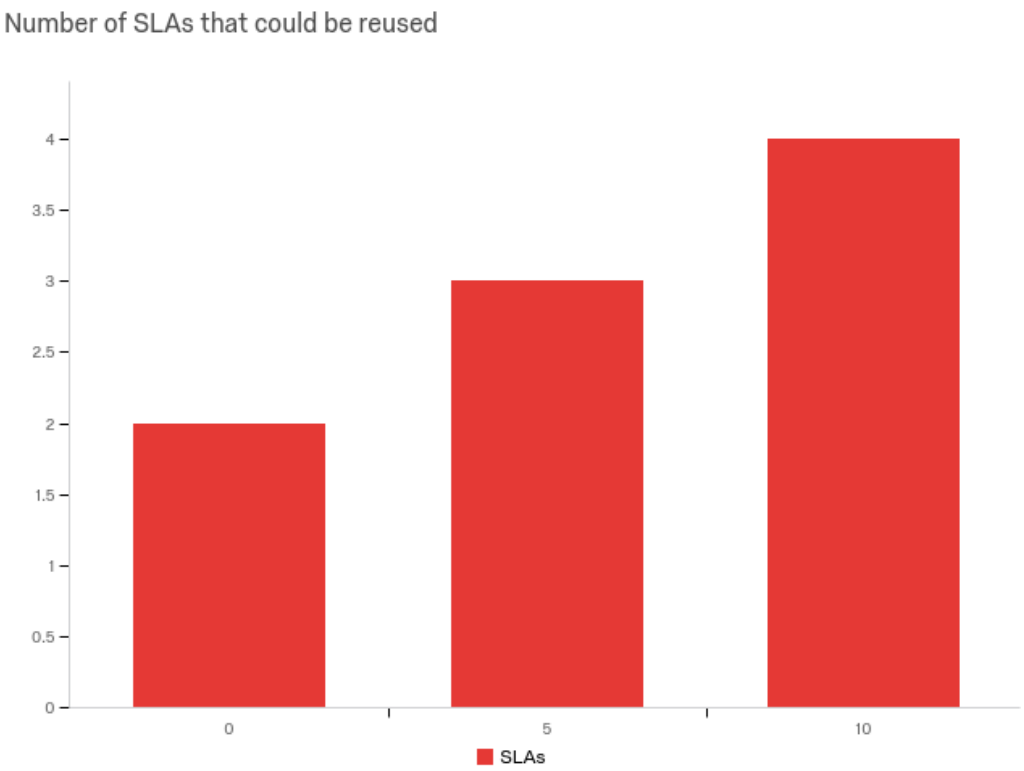

Figure 16: KPI 2 Reusability: Teachers' perspective – Question 5

The X axis indicates the number of SLAs that are re-usable in a particular content that has created. The Y axis indicates the number of teachers that re-use SLAs. According to the graph, 4 teachers re-used 10 SLAs, 3 teachers used 5 SLAs and 2 teachers did not re-use SLAs.

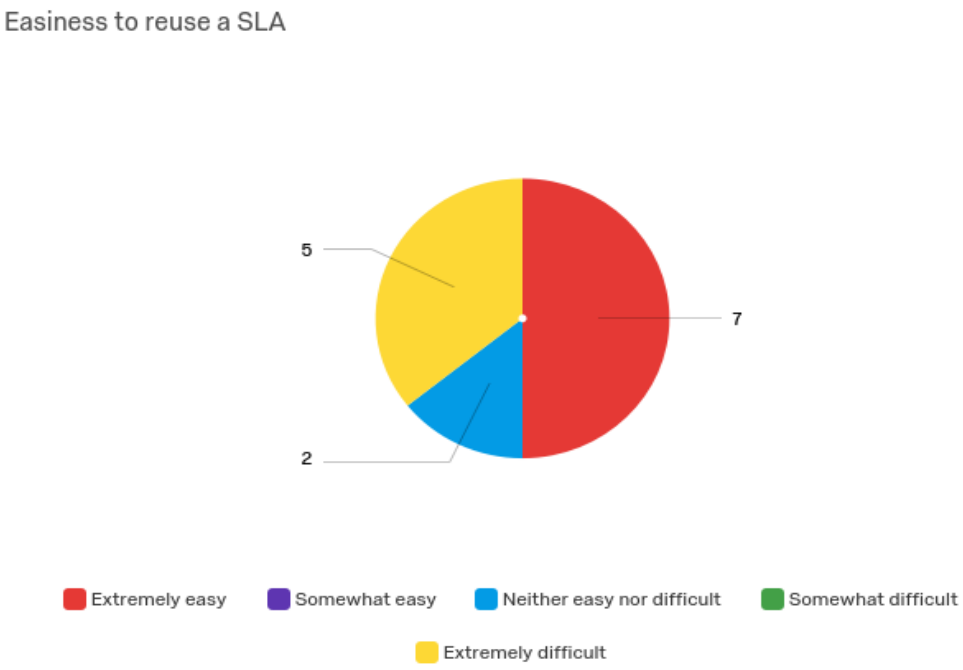

Figure 17: KPI 2 Reusability: Teachers' perspective – Question 6

Conclusions

Although at an early stage of the platform, where a small set of prototypical learning content (Learning Graphs, Smart Learning Actions) was created, typically one graph per institution and corresponding SLAs for each LG, the reusability attribute of SLAs was already recognized and brought forward.

Even if not practically implemented for the first pilots, teachers estimated that in most cases a large part of the SLAs that they have created can be reused in other Learning Graphs. With an average of around 4-5 SLAs defined per LG in the MEC, with each learning goal partitioned in into 2 SLAs or more, the fact that the majority of SLAs (5-10) were deemed as reusable in most cases is a strong attestation of the SLA concept's benefit to reusable learning content.

In terms of the ease of reuse of SLAs in different Learning Experiences, half of the interviewees had no problem with the concept and its practical implementation in their classrooms, a few of them were neutral, indicating a conceptual understanding but yet the need to get more familiarized with the idea, while the had a lot of difficulties reusing SLAs. In the next round of pilots, the focus will lie in investigating whether this difficulty stems from difficulty to adjust to the concept of the new educational approach supported by SLAs, or if the system's complexity poses these difficulties.

Regarding the creation of different learning graphs only a few teachers created different Learning Graphs. However, this was not the goal of this phase of pilots since more of the material was prepared by the consortium and explained to the teachers in order to instruct them for the subsequent phases.

7.4.3 KPI#3 Non-linearity

KPI#3 for non-linearity measures the ability and quality of MaTHiSiS system to create Learning Experiences that are decoupled from the traditional cascading activities support and rather support highly individualized goal-oriented Learning Experiences.

TEACHERS

Questions

In order to measure this KPI, the following questions were asked:

Were you satisfied with the non-linearity implementation?

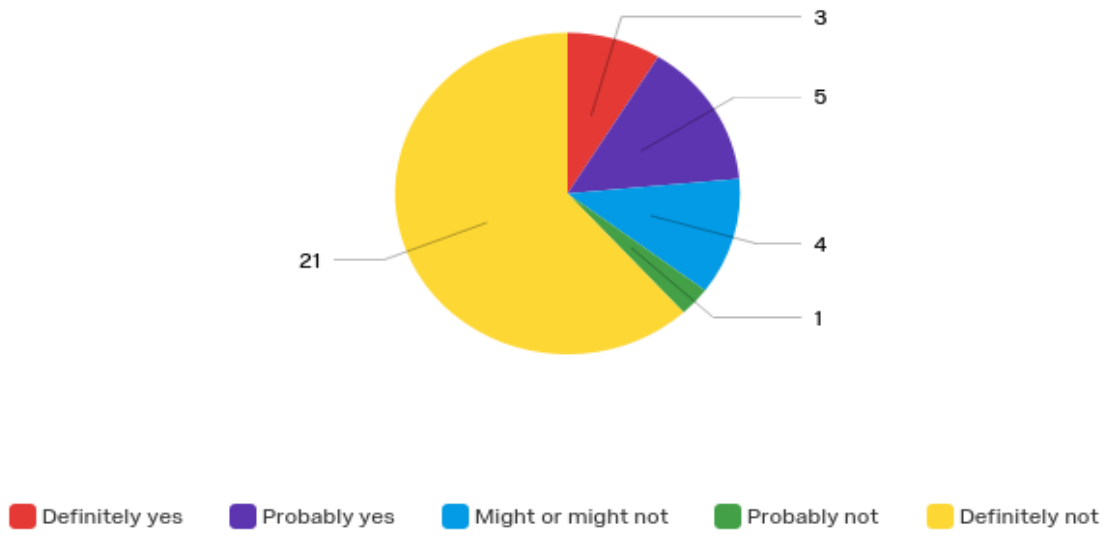

Figure 18: KPI 3 Non Linearity: Teachers' perspective – Question 1

Conclusions

The majority of the teachers/tutors were not satisfied with the non-linearity implementation of MaTHiSiS, with some positive indications however of the value of non-linear education in real world settings. This mandates the need to explore whether reduced satisfaction was a result of potential technical difficulties met during the learning process, which prohibited the proper deployment of the non-linear approach, or whether there are particular difficulties in transforming traditional linear educational approaches in certain specific contexts.

7.4.4 KPI#4 Accessibility

KPI#4 for accessibility measures the quality for MaTHiSiS to transfer the learning material in a way that is obtainable for the user or supports users with any physical, cognitive or sensory impairments. Also from a system service point of view, it measures the quality of MaTHiSiS to be available as a quick, reliable service throughout the architecture without interruptions and delay.

TEACHERS

Questions

In order to measure this KPI, the question below was asked. The numbers in the pie charts indicate the number of teachers that use the different platform agents.

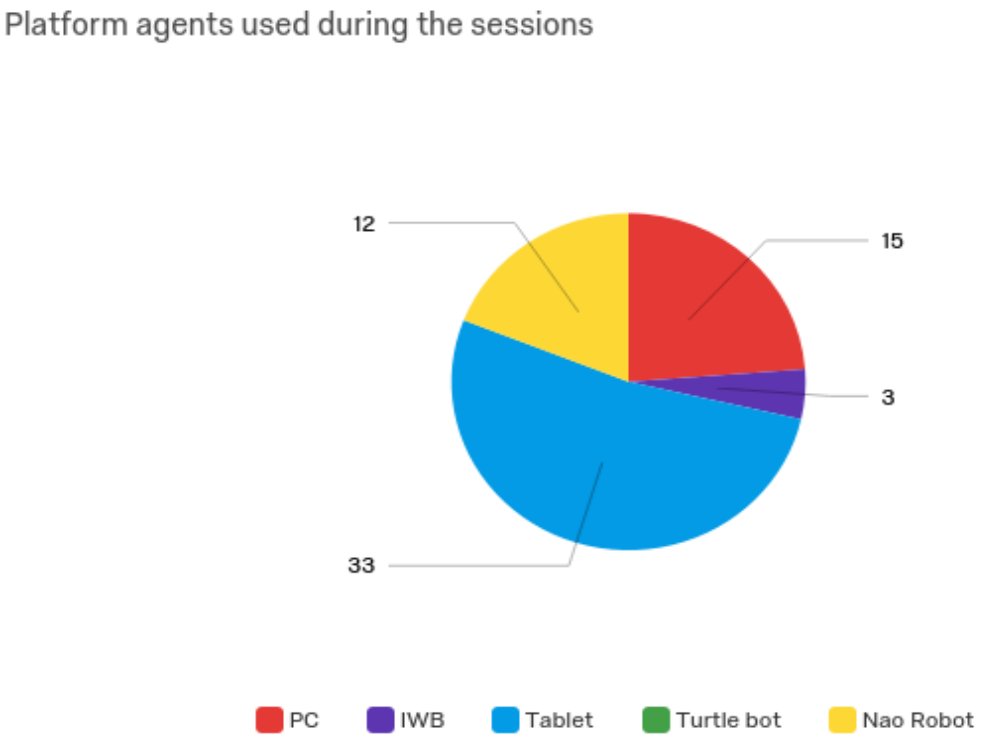

Figure 19: KPI 4 Accessibility: Teachers' perspective – Question 1

Conclusions

A large part of the sessions with the students were run with tablets and PCs as these platform agents are the more commonly available at schools and are easily to used. NAO robots were also used in a considerable number of sessions with the students as this agent is the preferred one for the learners and it has been demonstrated that, robots can add value in the learning process. The IWB was nearly ever used in the driver ASC pilots as very few learning materials were available when the sessions were ran. Further materials will be implemented for the assisted pilots. Finally, the learning scenarios using TurtleBots in the driver pilots were not implemented due to the low availability of this device in the schools. An analysis of the possibility of using these agents in the next phase has already been

started. The plan is to use these agents in the assisted pilots in specific learning scenarios with the TurtleBots of the consortium members.

LEARNERS

Questions

In order to measure this KPI, the following questions were asked:

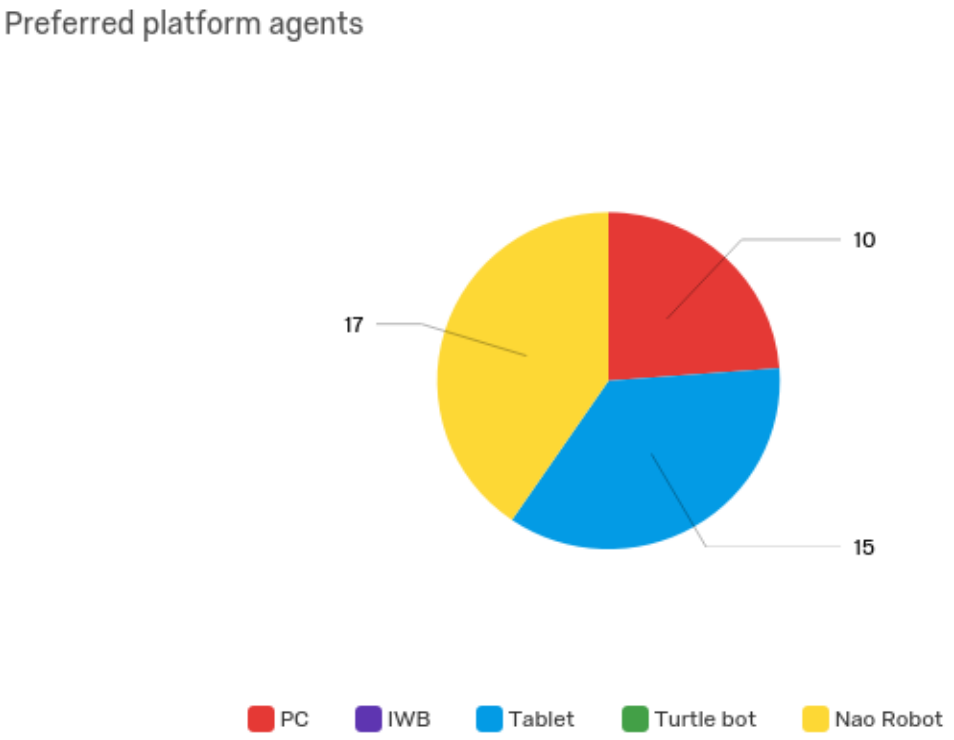

Figure 20: KPI 4 Accessibility: Learners' perspective – Question 1

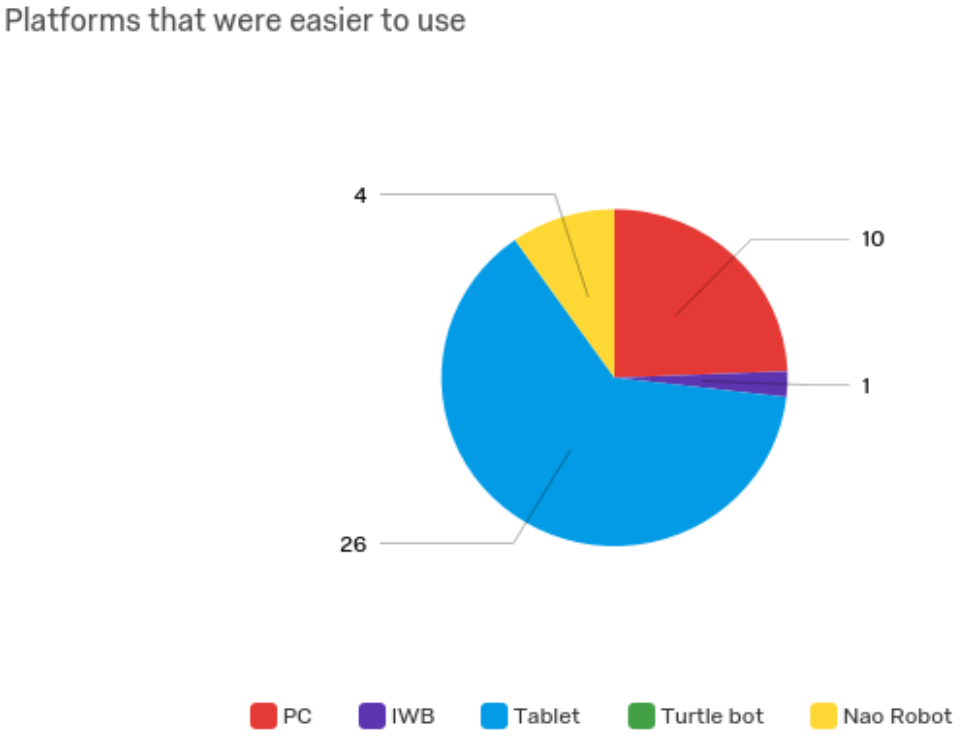

Figure 21: KPI 4 Accessibility: Learners' perspective – Question 2

Conclusions

As early on as at this stage, and with the usability of the system being continuously improved, the majority of the learners already found that the MaTHiSiS platform was very easy to use. This strengthens the concept of MaTHiSiS for seamless learning experiences with the use of technological learning facilitators (platform agents) in a fully integrated platform.

Furthermore, according to the responses, the NAO robot was the preferred agent for the students, although mobile devices and PCs. i.e. more traditional devices, were mostly available in the classrooms – and for this reason, and due to the familiarity with these PAs they were deemed easier to use. However, the preference to NAO practically affirms, in real-world settings, the value of humanoids robots such as NAO in the educational process. Students enjoyed learning with robots and they were really enthusiastic with them, apparent also in the results above, where in all cases where a NAO robot was available, it was the students' favorite platform agent. This fact validates the assumption that this kind of devices has significant opportunities for market penetration in the context of learning.

7.4.5 KPI#5 Ubiquity

KP#5 for ubiquity measures the ability of the MaTHiSiS platform to warrant efficient ubiquitous learning across a variety of educational contexts, i.e. learn anywhere, anytime for the same learning objectives. As for this first piloting phase the settings elected where solely the classrooms within the collaborating educational institutions, evaluation cannot be complete or reliable, but it should provide a first insight on this KPI.

TEACHERS

Questions

In order to measure this KPI, the following questions were asked:

Settings where the trainee could use this learning activity

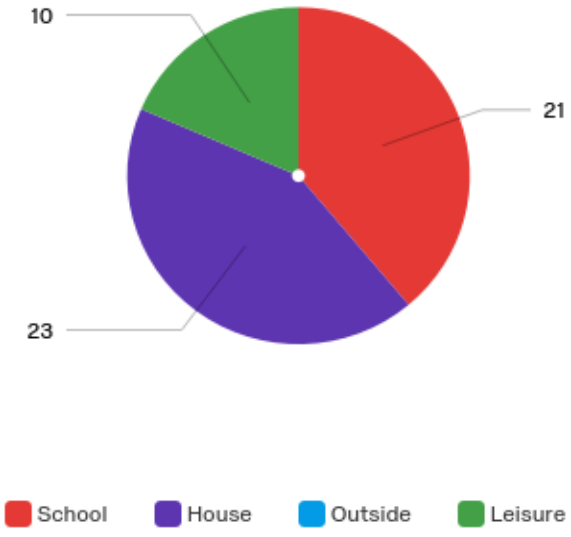

Figure 22: KPI 5 Ubiquity: Teachers' perspective – Question 1

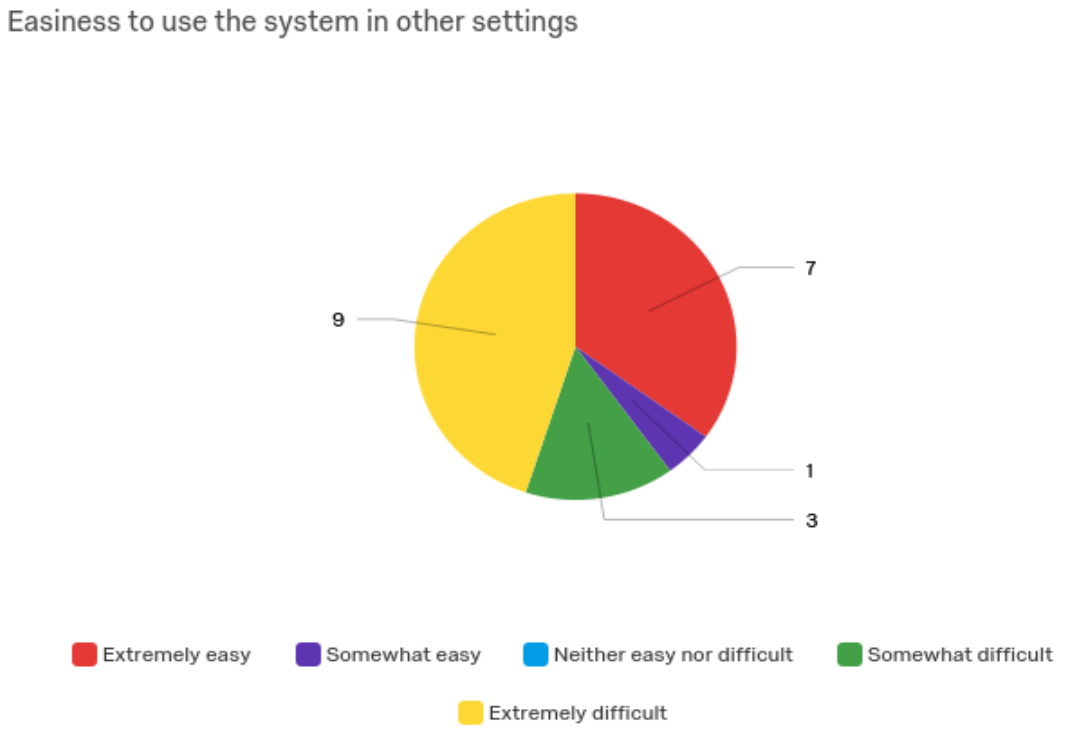

Figure 23: KPI 5 Ubiquity: Teachers' perspective – Question 2

Conclusions

The majority of the participants indicated that the schools and home as the most suitable places to use the MaTHiSiS platform. Other locations mentioned were study centers frequented by children and accommodation structures for disabled people as potential locations for the use of MaTHiSiS. The fact that although the first phase of piloting was held exclusively in the classrooms, the teachers immediately recognized the ability of MaTHiSiS to work outside of the classroom and different settings, is very encouraging.

The main restrictions they identified in regards to the ubiquity of use of MaTHiSiS were the difficulty of configuring the system without external support, the non-availability of some of the platform agents at home (i.e. NAOs or IWB) and the requirements for the Internet connection. The former, regarding the configuration difficulties, is expected to be improved in the next versions of the platform based also on the usability feedback. The unavailability of elaborate PAs, such as robots and IWBs, in private premises is expected, but the ubiquity of the system will be validated in subsequent pilots, where the availability of the full set of Learning Materials and the collaboration between Platform Agents will allow for the actuation of the Learning Experience in different settings with different PAs. Lastly, although Internet connection is inherent in the MaTHiSiS system, as planned for the final product, intranet solutions will be supported for local networks of educational institutions.

7.4.6 KPI#6 Ethical adherence

KP#6 for ethical adherence measures the quality of MaTHiSiS to apply appropriate ethical protocols of the technical/research institutions that are involved in the deployment of the MaTHiSiS components and also of the testing bed schools or organizations.

TEACHERS

Questions

In order to measure this KPI, the following question was asked:

Are there any ethical concerns with the system? All the participants respond that the system complies with the ethical requirements. As none of the respondents identified any ethical concerns, they were

not asked further questions.

Conclusions

The lack of ethical concerns with the system was due to the fact that the implementation of the system and the pilots are carried out in compliance with recognised legal and ethical conditions and obligations. MaTHiSiS ensures that the research and innovation activities, including the participation of human individuals and the processing of their data, take place in line with standard and the applicable international, EU and national law and in line with the expectation of research participants and data subjects.

8 Conclusion

This document describes the stages of implementation of the driver pilots in the Mainstream education Case: the involvement of the stakeholders, the development of the Learning Graphs in cooperation with the technical partners, the Data Acquisition phase, the training of the teachers and the practical implementation of the driver pilots with MEC learners.

The Driver Pilots implementation could have relied on the close collaboration of the end users. Since the first phase of development of the Learning Graphs, the teachers and the practitioners involved, realized the potential and the usefulness of the MaTHiSiS system for the daily teaching activity with MEC thanks to the student centered pedagogy, the affective state recognition and the adaptation and personalization of the learning path.

The MEC students were mostly chosen among those with a better approach with their less fortunate peers and were strongly involved sharing the pilots with their class mates and also in this respect MaTHiSiS system can represent an help for their inclusion.

The teachers were aware that they were testing a first version of the system and they were very collaborative in reporting promptly to technicians their difficulties. Beyond the malfunctions of integration between the various parts of the system, the main critical points encountered during the tests were the difficulty of set up: in subsequent pilot phases the users will have to proceed on their own and it will be therefore necessary for the technical partners to simplify this procedure. At the end of the Driver Pilots phase the feedback of the teachers and the practitioners were generally positive and the pupils largely enjoyed the sessions and liked the activities.

It is possible to say that the positive attitude and the interested feedback by the teachers were mostly based on the promise of what MaTHiSiS can do than on what it was possible to do already in this driver piloting phase when too many technical setting difficulties were faced.

The MEC have not a specific problem to face but widely diversified situations which involve several complex conditions and situations that can be very different from personal to familiar situations; the use of the system in the real environment showed some challenges that needs to be addressed in the next piloting phase: the PAs should reward more clearly the correct answers, a second try should be possible, the instructions should be more precise and the steps forward clearly identifiable but mostly the technical settings and use should be more friendly for non-technical users.

It could be also useful to register how the different score or utilization of the Pas and LMs can be different according the different personal situation of the MEC student involved and according the related LG. In this respect the technical and pedagogical partners will also have to work jointly in order to improve the process of adaptation and personalization of the LMs.

9 References

[1] Nottingham Trent University (ed.), D2.1 Formation of the stakeholder group. Deliverable of the MATHISIS project, 2016
[2] https://www.trinity.nottingham.sch.uk/general/2016/Trinity_Ofsted_2008.pdf
[3] Nottingham Trent University (ed.), D2.2 Full scenarios of use cases. Deliverable of the MATHISIS project, 2016
[4] Diginext (ed.) D2.4 Full System Architecture. Deliverable of the MATHISIS project, 2016
[5] CERTH (ed.), D4.2 MaTHiSiS Sensorial Component. Deliverable of the MATHISIS project, 2017
[6] CERTH (ed.) D4.1 MaTHiSiS Sensorial Component. Deliverable of the MATHISIS project, 2016
[7] Nottingham Trent University (ed.), D2.5 Evaluation Strategy. Deliverable of the MATHISIS project, 2017