Managing Affective-learning THrough Intelligent atoms and Smart InteractionS

D.8.4 Report on Profound and Multiple Learning Disabilities Case pilots

Workpackage	WP 8 - Pilots in Education
Editor(s):	Stefano Cobello, Elena Milli (PE), Marian Blanco, Ana Cabero (JCYL), Gosia Kwiatkowska (RIX), Marisé Gálvez Trigo (UoN), Marco Traversi (LCS), Ana Piñuela Marcos (ATOS), Dorothea Tsatsou (CERTH)
Responsible Partner:	Polo Europeo della Conoscenza
Quality Reviewers	Annaleda Mazzucato (FMD); Marco Traversi (LCS)
Status-Version:	Final – v1.0
Due date:	30/04/2017
Submission date:	10/07/2017
EC Distribution:	PU
Abstract:	This deliverable provides details for Profound and Multiple Learning Disabilities pilots as well as reports on the different measurable objectives set out for the specific pilots.
Keywords:	Driver Pilots; Profound and Multiple Learning Disabilities Case, Learning Graph, Learning Materials, Teachers Prospective.
Related Deliverable(s)	D2.1 Formation of stakeholder groups; D2.2 Full scenarios of all use cases; D2.5 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	12/06/2017	Stefano Cobello, Elena Milli (PE)	Initial draft
0.2	16/06/2017	Marian Blanco, Ana Cabero (JCYL)	JCYL input for the document
0.3	19/06/17	Gosia Kwiatkowska (RIX)	RIX Input
0.4	19/06/17	Marisé Gálvez Trigo (UoN)	Input on UoN and NTU related date for driver pilots
0.5	21/06/2017	Marco Traversi (LCS)	LCS input
0.6	22/06/2017	Marisé Gálvez Trigo (UoN)	Correction on numbers of participants in pilots and input of LGs
0.7	23/06/2017	Elena Milli, Stefano Cobello (PE)	Finalisation of the contents
0.8	03/07/2017	Elena Milli (PE)	Review and final amendment taking into account internal reviewers' comments
0.9	07/07/2017	Ana Piñuela (ATOS)	Final quality check
1.0	10/07/2017	Elena Milli, Stefano Cobello (PE)	FINAL VERSION TO BE SUBMITTED

The information and views set out in this document are those of the author(s) and do not necessarily reflect the official opinion of the European Union. Neither the European Union institutions and bodies nor any person acting on their behalf may be held responsible for the use which may be made of the information contained therein.

Table of Contents

List of Tables

List of Figures

List of Acronyms

Abbreviation / acronym	Description
ADHD	Attention Deficit Hyperactivity Disorder
ASC	Autistic Spectrum Case
ASD	Autistic Spectrum Disorder
CGDLC	Career Guidance Distance Learning Case
CLS	Cloud-based Learners' Space
EOPPEP	EOPPEP is the National Organisation for the Certification of Qualifications and Vocational Guidance in Greece
DSS	Decision Support System
FMD	Fondazione Mondo Digitale
HCI	Human Computer Interaction
ID	Intellectual Disability
ITC	Industrial Training Case
IWB	Interactive White Board
JCYL	Consejería de Educación Junta de Castilla y León
KPI	Key Performance Indicator
LCS	La Cometa del Sud
LA	Learning Action
LAM	Learning Action Materialisation
LG	Learning Graph
LO	Learning Objective
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	RIX Research and Media

Abbreviation / acronym	Description
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 artefacts, 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 behavioural 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 behaviour 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/behavioural 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 an overview of the process of preparation and implementation of the Driver Pilot phase of Profound and Multiple Learning Disabilities Use Case in the frame of the Work Package Pilots in Education.

The Driver Pilots for PMLDC had the purpose to test the system in real environment, train it to response to the users' behaviour, give feedback to the project partners to enhance and improve the features of the platform and the other components of the system. The Driver Pilots also provided information on the reaction of the users to the system and the learning experience, giving feedback to the design team for their improvement.

The structure of the learning experience is based on the concept of Learning Graph: this structural tool is associated with specific Learning Goals and composed by Smart Learning Atoms and the relations among them and the learning goal itself, it allows to reach the learning and training objective. The Smart Learning Atoms (SLAs) are learning elements that carry stand-alone, atomic and complete pieces of knowledge which can be learned and assessed in a single, short-term iteration, targeting certain problems. The SLAs are conveyed by the Learning actions (LA) precise activities to be deployed in the real world, which each MaTHiSiS platform agent (PA) interprets in different ways, based on the Learning Materials (LM) available in different learning environments.

Some of the stakeholders identified in the D.2.1 "Formation of the stakeholder group" [1] were involved by the partners since the M6 (June 2016) for the development of the Learning Graph collected in the D2.2 "Full scenarios for all use cases" [2], this allowed the pilot partners to have an active collaboration with the teachers and the practitioners working with PMLD learners. Their cooperation was essential since this Use Case conveys several challenges linked to the (often) unique conditions of the students at cognitive and physical level. Moreover these conditions require a strong mechanism of data collection and adaptation to the affective state. After the piloting sessions the partners collected feedback and comments from teachers and learners (when possible) in order to have the users point of view on the potentialities of MaTHiSiS in the special needs education.

In the driver phase of the PMLD that took place in May and June 2017, the pilots ran in 3 different countries, the UK, Italy and Spain and from 11 different schools involving in general 17 tutors, 15 teachers, 6 psychologists and 40 learners.

The involved schools were:

- The UK
  Oak Field School and Sports College
  Nethergate School
  Charlton Park Academy
- Italy
  Istituto Comprensivo Leonanrdo da Vinci – Bussolengo (VR)Association FareABA
  Social Cooperative Il Mosaico
  Primary school I Circolo Didattico, Cava De' Tirreni
- Spain
  Centro de Educación Especial "Nº 1"
  CEIP "Gonzalo de Berceo"

This deliverable contributes to the internal plan and development of the Assisted Pilot phase giving to the project partners information on the evaluation of the system, the response of the MaTHiSiS prototype in the real life environments, the end users expectations and further requirements, the pedagogical potential foreseen by the practitioners. For readers external to the project, this

deliverable describes the implementation process of the Driver Pilots for users affected by Profound and Multiple Learning Disabilities, the characteristics of the stakeholders, learners and learning environments, the developed Learning Graphs and Learning Materials and gives the analysis of the feedback from the users.

1 Introduction

The objective of this deliverable is to provide an overview of the implementation of the Driver Pilots phase for the Profound and Multiple Learning Disabilities Case. 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 centred approach was applied since the very beginning: pedagogical partners cooperated with teachers and practitioners working with PMLD in order to analyse 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 Profound and Multiple Learning Disabilities Case and associated challenges, goals and learning scenarios.
2. Pilot deployment plan including the three phases (driver, assisted and real-life) and the roles of the different stakeholders involved in the pilots.
3. Driver Pilots preparation activities including: selection of stakeholders, analysis of users' requirements, development of Smart Learning Atoms, venue setting and teachers training.
4. Driver Pilots execution with the description of the stakeholders involved; the user characteristics, physical, social and learning environment and the Learning Materials used.
5. Evaluation of the system.
6. Conclusions

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 the use of ICT.

2 Profound and Multiple Learning Disabilities Case

2.1 Brief description of Profound and Multiple Learning Disabilities

We consider a learner with profound and multiple learning disabilities to be a pupil who has two or more of the following:

- physical disability,
- intellectual disability,
- hearing impairment,
- visual disability,
- very significant communication and language disorders,
- severe personality disorders,
- other disabilities.

In other words learners with PMLD have a profound cognitive impairment, significant motor or sensory impairments, operating overall at a very early developmental level [3]. Frequently they have complex health care needs associated with medical condition which may include neurological problems.

People with a severe or profound intellectual disability recognise familiar people and may have strong relationships with key people in their lives. They have little or no speech and relies on gestures, facial expression and body language to communicate and they require lifelong help with personal care tasks, communication [4]. The social functioning is extremely delayed, they may have limited ability to engage verbally and often require those who are familiar with them to interpret their communication intent. They have the chance to engage and to achieve their optimum potential in a highly structured environment with constant support and an individualized relationship with a carer [5].

Intellectual disabilities are estimated to affect between 1% to 2% of the population in most western countries and currently 20% of the population with intellectual disabilities will be of school age [6]. The large rise in the number of children with profound and multiple disabilities can be attributed to an increase in the survival of premature babies due to medical advances made in recent years [7].

The range of disabilities involved in the Driver Pilots phase of MaTHiSiS was wide: tetra-paresis, cerebral palsy, sensory and physical impairments, from moderate to severe mental disability, learning disability, limited verbal communication, attention deficit hyperactivity disorder (ADHD), memory and learning deficits, behavioural disorders, no proper gross or fine motor skills.

2.2 Associated challenges, Goals and Example Scenarios

There is a variety of challenges associated to this use case, mainly connected to the different physical, cognitive and social conditions of the learners with PMLD.

Learners with physical disabilities often depend on the others to move. For them learning to navigate electric wheelchair and orient themselves in the environment can improve the opportunities of independence.

One of the most important learning goals for PMLD students is communication, since it underpins all aspects of life and all other learning. Communication is essential for gaining some level of independence and control. Many young people with profound and multiple learning disabilities have poor verbal communication, those around them must infer, attribute or interpret meanings from the person's behaviours. For those who can approximate a single word (or understand a single Makaton

sign [8]) teachers and carers are keen to assist them to build on this skill to achieve: clearer enunciation of the word, increase their vocabulary, combine words meaningfully and learn to take turns to enable two way communication.

People with multiple disabilities are likely to have difficulty to understand the behaviours of others and also to transmit meaning or content by their actions or movements. For the learners with associated personality and behavioural disorders it is important to improve the emotional awareness to maintaining mental health, social connectedness and inclusion.

The goal of the MaTHiSiS pilots will be to verify to which extent the ecosystem can support teachers, care givers, tutors and learners' teaching and learning to develop a set of skills that will allow them to improve their independence strengthening motor or communication skills, not only at a verbal level but also improving the emotional awareness. Many benefits are perceived for the application of technologies to support special-needs students developing academic, social, and behavioural skills, while also providing greater access to a general curriculum integrating them within mainstream school settings.

3 Pilots Deployment Plan

3.1 Pilot 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 [2] and D2.3 [9].

Administrator (Super-admin - Pilot site admin): Users with this role will be 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. Special Needs Teacher is a teacher 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 the mainstream schools.

Tutor role will have pedagogical knowledge and skills that will allow them to:

- Set up 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).

Learner: This role is the most important stakeholder in MaTHiSiS. Supervised learners 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.

Learners will be able to follow a specified learning experience interacting with any of the PAs (mobiles, robot, IWB and desktop/laptop).

4 PMLD Pilots Preparation Activities

4.1 Stakeholder Selection

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

For the Driver Pilot phase teachers and practitioners from eight organisations were involved: four special schools (three form UK and one from Spain) enrolling students from 5 to 19 years, three mainstream primary schools that include PMLD students (two Italian schools with students from 6 to 10 years and a Spanish school with students from 3 to 12 years) and an educational centre with users from 5 to 19 years.

4.1.1 UK

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

Organisation Name	*Oak Field School and Sports College*
General Description of the Organisation	Day school for children with autism and learning disabilities aged 3 to 19 years old. It is an all-through community special school maintained by the Nottingham City Education Authority for boys and girls aged 3 - 19 years. It provides day education for children and young people with autistic spectrum disorders and profound and multiple learning disabilities whose learning challenges are best served in a special school setting. Currently, there are approximately 156 pupils on roll. OFSTED inspectors rated Oak Field School as Outstanding in their last inspection in 2014. The school holds the International School Award, Youth Sport Trust Gold, Ability Nottingham, Basic Skills Award, Healthy Schools Gold, eTwinning Award, Lets Get Cooking Accredited and Arts Mark Gold.
Description of the Characteristics of the Services users at that Organisation	All the students attending Oak Field School have, or are being assessed for, statements of special educational needs. Almost all have extensive, complex learning and physical disabilities. A high proportion of students, especially in the Early Years, have highly complex medical needs.
Support Mechanisms for the use cases	The school has PCs, iPads, IWBs and a Wisefloor projector. However, none of the PCs meets the technical specifications required by MaTHiSiS. A NAO robot owned by UoN and other equipment bought by NTU will be shared between both universities and used during the pilots.
Motivation to participate	The school has been involved with UoN and NTU in research projects using different types of technologies for a long time. They really appreciate and know the big potential of these technologies to help their students and staff. Oak Field School is very keen to see what MaTHiSiS will offer.

Table 2: Stakeholder information: Oak Field School and Sports College

4.1.1.2 University of Nottingham - UoN

Organisation Name	*Nethergate School*
General Description of the Organisation	Nethergate School is a day co-educational academy in the city of Nottingham which provides education for children and young people with special educational needs aged 5 to 19 years old. It is an academy special converter school maintained by the Nottingham Local authority for boys

	and girls aged 5 - 19 years. Currently, there are approximately 100 students on roll. This Academy is sponsored by the Greenwood Academies Trust which was formed in 2009 and now educates approximately 16,000 pupils across eight local authority areas including Nottingham City, Nottinghamshire, Derby City, Leicester City, Northamptonshire, Peterborough, Lincolnshire and Central Bedfordshire.
Description of the Characteristics of the Services users at that Organisation	The school caters for pupils with moderate and complex learning difficulties, including autistic spectrum disorders, behavioural emotional and social difficulties, speech, language and communication disorders. All pupils have a statement of special educational needs.
Support Mechanisms for the use cases	The school has PCs, iPads and IWBs. However, none of the PCs meets the technical specifications required by MaTHiSiS. A NAO robot owned by UoN and other equipment bought by NTU will be shared between both universities and used during the pilots.
Motivation to participate	The school is very keen to introduce new technologies in the classroom, as they will help students to keep motivated and engaged. They are very enthusiastic about participating in MaTHiSiS.

Table 3: Stakeholder information: Nethergate School

4.1.1.3 Rix Research and Media - RIX

Organisation Name	*Charlton Park Academy*
General Description of the Organisation	Charlton Park Academy is a Secondary Special Academy for students with complex (11-19), low incidence special educational needs based in the London Royal Borough of Greenwich, UK. The school has fully adopted the unique Multimedia Advocacy approach developed by RIX Research & Media. The School uses RIX Wikis for all 240 of its pupils and the recent Ofsted Residential Inspection Report has highlighted how the use of Wikis has enabled very effective person-centred planning.
Description of the Characteristics of the Services users at that Organisation	The Charlton Park Academy caters for young people (11-19) with Special Educational Needs (SEN). The 8 students who are taking part in the PMLD cases are young people between the ages 11-14. They have Profound and Multiple Learning disabilities diagnosis.
Support Mechanisms for the use cases	Existing technologies routinely used in the school include: iPads (over 100 iPads used in this school), Android Tablets, Whiteboards in each classroom, PC's, EyeGaze, 3D printer, Design Technology - Design cuter, Sensory Guru Equipment, OMI interactive, Tomocco, personalised communication devices e.g. VOCA, Paphfinder and others. All staff are trained to use existing technologies and are experienced in using and supporting students to use existing hardware and software. The school is investing in NAO robot that should arrive for the Assisted Pilots.
Motivation to participate	The school is really keen to participate and have been extremely accommodating. The young people are motivated by the use of new technologies and rewards. The use of interactive games helps with their learning.

Table 4: Stakeholder information: Charlton Park Academy

4.1.2 Italy

4.1.2.1 Polo Europeo della Conoscenza - PE

Organisation Name	*Istituto Comprensivo Leonardo da Vinci – Bussolengo (VR)*
General Description	Istituto Comprensivo Leonardo da Vinci includes about 2000 students from

of the Organisation	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 pupils from 3 to 5 years old 3 Primary schools with pupils 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 curricula.
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: Stakeholder information: I.C. Leonardo Da Vinci

Organisation Name	*Social Cooperative Il Mosaico*
General Description of the Organisation	The social cooperative Il Mosaico is located in Marche region and provides educational services to students from 3 to 19 years old with social and educational needs reported by Social Assistance, Schools and Health Centres, or to private clients. The staff is composed of pedagogy specialists, psychologists, professional educators, teachers, youth workers and skilled operators with considerable experience and theoretical competence. They also manage a Specialised Centre for Diagnosis and Empowerment for Learning Difficulties. The students are from families with several issues: drugs and alcohol addiction, low educational levels, crime, social exclusion, psychiatric disorders, and from immigrant families. Several users has disabilities.
Description of the Characteristics of the Services users at that Organisation	In cooperation with the Social Assistance Service, the users are from families with several issues: drugs and alcohol addiction, low educational levels, crime, social exclusion, psychiatric disorders, and from immigrant families. In particular this Centre offers a specialised service for autistic and disabled children in cooperation with the teachers and the Health Service structures of the territory.
Support Mechanisms for the use cases	The professionals from this organisation involved in MaTHiSiS are a pedagogy specialist with experience in working with children with special needs, learning disabilities and behavioural issues, and a developmental psychologist and family psychotherapist. The venue has been equipped with the required technological materials.
Motivation to participate	Il Mosaico participated to the piloting phase of the project to explore the possibility to offer new and innovative services to their users.

Table 6: Stakeholder information: Social Cooperative Il Mosaico

4.1.2.2 La Cometa del Sud - LCS

Organisation Name	*Primary school I Circolo Didattico, Cava De' Tirreni*
General Description of the Organisation	The school is a primary public school (students aged from 6 to 10 years old) in Cava dei Tirreni (Salerno).

	Since 2013, the "I Circolo Didattico" has 3 location in different areas of the city but the driver pilots took place in the main one, named "Don Bosco", in the city centre. The school has two canteen for the kids and for the afternoon classes, a fully equipped, a modern gym, 25 classrooms with a IWB, a children friendly library, a multi-media library, some labs with IWB: linguistic, multi-media, scientific, musical), ICT, historical - geographical and artistic.
Description of the Characteristics of the Services users at that Organisation	In the Driver Pilots were involved children aged 6 to 12 years with language-specific disorders and different physical disabilities, cognitive and global developmental delays, short attention span.
Support Mechanisms for the use cases	The school was provided with the required technologies (tablets, PCs). The teachers were available and trained for the first phase of the project
Motivation to participate	I Circolo Didattico participated with great interest and motivation for introducing innovations and new ICT tools that can help improve the quality and learning of pupils with disabilities and as a training for their teachers.

Table 7: Stakeholder information: Primary school I Circolo Didattico

4.1.3 Spain

4.1.3.1 Consejería de Educación – Junta de Castilla y León – JCYL

Organisation Name	*Centro de Educación Especial "Nº 1"*
General Description of the Organisation	Special Education Centre, with 75 pupils, 49 of them have profound and multiple learning disabilities. The school has 24 teachers (22 support teachers and 3 specialists in language, 14 educational assistants, 3 physiotherapists and 2 nurses). They have received training on "experimenting and learning with tablets".
Description of the Characteristics of the Services users at that Organisation	Students aged 5-19 years old will be involved. They have a range of severe and profound learning and/or physical, and/or psychological disabilities.
Support Mechanisms for the use cases	Teachers have experience and have been trained in the use of interactive smart boards, tablets and computers. A range of tablets, the IWB and a NAO robot were also available for use in the project
Motivation to participate	CEE "nº 1" participated in the driver pilot phase due to their interest on the introduction of new ICT tools and innovation that can help to improve the quality of life and also the learning of PMLD pupils. They believe that MaTHiSiS could support the learning process by helping the teacher to personalize it to levels not developed by other ICT tools until now. They feel really curious and enthusiastic about what could mean on the learning process the introduction of passive sensors that detect emotional states and the personalization of the learning path considering individual characteristics on PMLD cases.

Table 8: Stakeholder information: C.E.E. "nº 1"

Organisation Name	*CEIP "Gonzalo de Berceo"*
General Description of the Organisation	This is an infant and primary school. - There are around 300 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	Students' ages range from 3-12 years, and are in mainstream education. In each class there will be at least 2 students with different disabilities and/or other learning difficulties.
Support Mechanisms for the use cases	Teachers have experience and have been trained in using interactive smart boards, tablets and computers. There are IWB in every classroom.
Motivation to participate	CEIP Gonzalo de Berceo participated in the driver pilot phase due to their interest on the use ofnew ICT tools that can improve learning process by the introduction of passive sensors that detect emotional states and the personalization of the learning path considering individual characteristics on PMLDC.

Table 9: Stakeholder information: CEIP "Gonzalo de Berceo"

4.2 User and system requirements elicitation phase

Following stakeholders 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 [2] from semi-structured interviews with domain experts (teachers, trainers and 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 [9].

4.3 Data Acquisition Phase

Collection of data for training affect analysis algorithms have been carried out by partners in cooperation with selected stakeholders at the schools venues, 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 [10].

In short, the data acquisition tool aimed to gather ground truth regarding user (learner) behaviour, 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 behaviour.

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 three 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 [12] and D4.2 [11]. 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

Smart Learning Atoms (SLAs) are atomic and complete pieces of learner knowledge, competence and/or skills, which can be learned and assessed in a single, short-term learning process iteration. SLAs essentially comprise primordial learning goals, constituents of more advanced learning goals, which cannot be further reduced to more primitive notions. In a nutshell: the simplest of concepts pertaining to what-to-learn, SLA is a small learning goals. Each pilot partner was involved in the development of SLA for their pilots. The development of those was informed by previously collected user requirements and individual user profiles.

4.4.1 UK

4.4.1.1 University of Nottingham – UoN and Nottingham Trent University

UoN and NTU organised their Driver Pilots to take place at Oak Field School (UoN and NTU) and Nethergate School (UoN). The SLAs to use were created with help of another school that finally could not participate in the project. These SLAs were discussed and validated with teachers from Oak Field School and Nethergate School in order to make sure that they were suitable for their students. For the Driver Pilots, a Learning Graph to be used with the NAO robot was designed. This Learning Graph includes the following SLAs:

- Objects recognition
- Action words recognition
- Descriptor words recognition
- Pronunciation (for vocal students)
- Left-right identification
- Area recognition
- Targeted location navigation
- Sorting
- Order of events

The above atoms were included in the Sequencing-Vocabulary-Navigation Learning Graph. The level of support required by each children was also taken into consideration and a separate graph for those students that cannot read or that are not vocal was developed.

4.4.1.2 University of East London - UEL

RIX@UEL delivered their Driver Pilots at Charlton Park Academy. The students involved have been diagnosed with PMLD and other complex additional learning needs. The school is using RIX Wiki, an

online, private and password protected tool that enables each students to capture their goals, aspirations and achievements. The aim of this pilot is to enable the young people to access their Wiki independently and share some of their information. This task has been developed into the following Smart Learning Atoms:

- Recognition of RIX Wiki symbol/object/picture;
- Selection of the RIX Wiki symbol/object/picture;
- Association that RIX Wiki symbol selection gives them access to their Wiki.

The above atoms were included in the Cause and Effect Learning Graph.

4.4.2 Italy

4.4.2.1 **Polo Europeo della Conoscenza - PE**

PE delivers the Driver Pilot in two different venues, the special need teachers and the professionals identified specific Learning Goals for each pupil involved in this phase, considering their individual educational needs, the environment, the level of development.

At the I.C. "Leonardo da Vinci" of Bussolengo (Verona) the SLAs developed where the same as the mainstream class attended by the pupil:

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

At the social cooperative "Il Mosaico" of Porto Potenza Picena (Macerata) in one case the SLAs concerned mostly the emotion area:

- Emotional awareness
- Eye contact
- Imitation
- Basic emotion recognition
- Basic emotion expression

In the second, and more severe, case the SLAs focused more on the improvement of the basic competences:

- Number quantity correspondence
- Discrimination of greater than /less than
- Object recognition
- Action words recognition
- Descriptor words recognition
- Pronunciation (Improvement)
- Left/right identification

4.4.2.2 **La Cometa del Sud - LCS**

LCS was only marginally involved in this phase and used the mainstream SLAs created by FMD for ASC after checked them with the teachers and the director of the school to verify they were useful for their students. The Learning Graph included the following SLAs:

- 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

4.4.3.1 **Consejería de Educación. Junta de Castilla y León - JCYL**

JCYL delivered their Driver Pilots at CEIP "Gonzalo de Berceo" and CEE "nº 1". In the venues there were IWB, computers and tablets and the partner provided Kinect v2, HD web camera and NAO robot as well as tablets to the schools that do not meet the technical requirements. Both venues had a dedicated room to run the pilots with good internet connection and comfortable enough either for pupils and teachers. Teachers found MaTHiSiS could be a chance for improving children emotional awareness skills. This task has been developed into the following Smart Learning Atoms:

- Emotional awareness
- Eye contact
- Imitation
- Basic emotions recognition

The above atoms were included in the Improving emotional skills Learning Graph. The level of support required by each children has been also taken into consideration during the implementation.

4.5 Setting of the Venue

4.5.1 UK

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

PMLD Driver Pilots ran by UoN and NTU took place at Oak Field School in Nottingham. Sessions were scheduled at Nethergate School as well, but due to technical issues and time limitations it was not possible to run any effective session there. Both schools were familiar with the use of various interactive technologies, but their access to the Internet was very limited and the equipment that they had do not meet the requirements needed by MaTHiSiS. For this reason, a 4G mifi router was obtained, along with two laptops that had been previously used during the Data Collection phase of MaTHiSiS, and two Kinect v2. A NAO robot from UoN was also used during these pilots. The environment was set up with the laptop on a table close to the student and a NAO robot connected through a network cable to the laptop. The student had to be in front of the NAO robot and interact with it during the sessions. Due to the level of support needed by most students, staff from the schools and the research team from UoN and NTU were required to work on a 1:1 basis with them. The duration of each session was dependant on each student, so some sessions lasted less time and in other cases more time than what was envisaged. Most sessions should have lasted between 15 - 30 minutes from start to end.

4.5.1.2 University of East London - UEL

PMLD Pilots ran by RIX@UEL took place at the Charlton Park Academy in the South-East of London. The school has an excellent range of assistive technologies and access to the internet is generally good. Pilot sessions took place in a small IT suite that was equipped with an interactive whiteboard, 9 online desktop computers and tablets which can also be used in this space. Charlton Park Academy pilots required staff and the research team to work with each student on a 1:1 basis due to the level of disability and support needed. The duration of each session varies depending on student' concentration levels. Generally, each session with students lasted between 10 and 20 minutes. A table with laptop and tablet was set-up in one of the corners of the room. A whiteboard was connected to the laptop and available for pilot participants to access the learning experience.

4.5.2 Italy

4.5.3 Polo Europeo della Conoscenza - PE

PE planned to run the Driver Pilots for the PMLD use case in two different venues: the I.C. "Leonardo da Vinci" of Bussolengo (Verona) and the social cooperative "Il Mosaico" of Porto Potenza Picena (Macerata). Each venue was equipped by the partner with laptop, Kinect v2, HD web camera, tablets and was foreseen the use of a NAO robot in Bussolengo. In both venues the pilot took place in a dedicated room with good internet connection and enough space to let the pupils feel comfortable. The duration of the session was between 10 and 20 minutes according to the age and the

seriousness of the disability. Longer sessions, breaks and pauses were foreseen due to technical reasons.

4.5.3.1 La Cometa del Sud - LCS

LCS ran the Driver Pilots at the primary school I Circolo Didattico in Cava dei Tirreni (Salerno) in the city centre. The school is one of the best ranked in the area and particularly well equipped, compared to the average of the other schools of the area. The school has in particular an ICT LAB equipped with 12 pc and several tablets. In this lab LCS settled the additional Mathisis equipment: a Kinect v2, a tablet, a smartphone and a wide screen. The students worked 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 also due to some mis-functioning of the system.

4.5.4 Spain

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

PMLD Driver Pilots run by **JCYL** took place at CEIP "Gonzalo de Berceo" and CEE "nº 1". CEIP "Gonzalo de Berceo" has an excellent range of technologies (IWB, laptops and tablets under technical requirements) and access to the internet is generally good. Driver Pilot sessions at CEIP "Gonzalo de Berceo" took place in a small classroom where both NAO robot and tablets could be used. Related to CEE "nº 1", Driver Pilots took place in the ICT classroom with good access to internet and devices under technical requirements. The duration of each session varied depending on the technical performance of the platform and student' concentration levels. In general terms the duration of each session was about 15-20 minutes (45 minutes including the PA setup).

4.6 Teachers Training

4.6.1 UK

4.6.1.1 University of Nottingham – UoN and Nottingham Trent University

At Oak Field School, UK, one teacher and two teaching assistants were actively involved with UoN and NTU in the Driver Pilots, but due to technical issues it was not possible to involve all the classes that had an interest on it. A general introduction to the system was given to the Head Teacher and other teachers at the school before the start date of the Driver Pilots. A more detailed explanation of the system was given to the teacher and teaching assistant that used MaTHiSiS with their students, and the research team from UoN and NTU was available to give support and lead the Driver Pilots.

At Nethergate School, UK, their ICT teacher was involved in the preparation of the Driver Pilots with UoN. Although it was not possible to carry out the scheduled sessions due to technical issues and time limitations, as at Oak Field School, a general introduction to the system followed by a more detailed explanation was given.

At Charlton Park Academy UK, there were four teachers involved in the MaTHiSiS pilots assisted by RIX researchers. Each teacher was introduced to the system by a member of the research team. The technical assistant at the school was able to provide support and training to other staff and assists the project research team during all pilot sessions. All teachers at the Charlton Park Academy were competent in using technology and were enthusiastic in pioneering and testing the MaTHiSiS system. Since the system was not yet mature enough to be intuitive and easy to use, teachers require full assistance from researchers in using and testing the system.

4.6.2 Italy

4.6.2.1 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 two 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.

4.6.2.2 **La Cometa del Sud - LCS**

LCS ran the driver pilots during May and June 2017 with three tutors from its staff and a group of nine teachers (four of them involved for PLMD use case). The interaction with the teachers was constant as they needed support because of their lack of ICT skill and the occasional presence of the technical assistant of the school. Teachers were very helpful, encouraging the children to work with the PAs and to keep them always concentrate on the task.

4.6.3 Spain

At CEIP Gonzalo de Berceo there were two teachers involved in the MaTHiSiS driver pilots whileon four teachers participated in the pilot in the CEE "Nº 1". All of them began to work with **JCYL** in 2016, when the creation of the Learning Graphs started. Before the driver pilots took place, the teachers provided the input necessary to fill the learning profile of the MaTHiSiS platform and they were introduced to the MaTHiSiS platform. All the teachers of CEIP "Gonzalo de Berceo" and CEE "nº 1" were competent in the use of technology for pedagogical purposes and they were highly involved in the testing of the MaTHiSiS system. As foreseen in the driver pilots, the teachers required assistance since the system was not yet intuitive nor easy to use.

5 PMLDC Driver Pilot Execution

5.1 Introduction

The project partners organised the Driver pilots at the venues of the stakeholders, in order to guarantee users comfort and assistance. The timing of the pilots was established following the recommendations of teachers and practitioners and the technical readiness of the MaTHiSiS system. All the precautions were taken in order to ensure the minimum level of distress for the users involved. The legal representative of the schools and organisations, the parents and the students involved in the pilots were informed about the data collection and the data protection.

None of the pilot venues had all the required technical equipment and the pilot partners provided the missing material: a laptop with Windows 10, Kinect v2, high-resolution web camera, routers for internet connection and the PAs (mobile devices - tablets and/or smartphones - and NAO robots). All the pilots occurred in a dedicated room in order to not interfere with the daily routine of the students and the teachers not involved in the project. The sessions were run in presence of one or two tutors from MaTHiSiS partners and the teachers (or practitioners) assisting the pupil (often on a 1:1 basis work). The practical arrangement of the room and the implementation of the session depended on the physical and cognitive condition of the user.

Approximately sixteen tutors were committed in the driver pilot phase providing support to teachers together with the technical assistants. Tutors had pedagogical skill and experience and they were trained on MaTHiSiS functionalities.

The pilot partners involved several teachers and practitioners since the first phase of definition of the Learning Graphs. Approximately sixteen of them were trained on the MaTHiSiS functionalities and directly involved in the implementation of the pilots in their venues. All these professionals were strongly committed in the piloting phase and expressed a great interest for the possible use of the system in their daily activity.

During the driver pilot phase thirty-nine PMLD learners were involved aged 6 to 19 with session that lasted 10 - 30 minutes depending on their conditions; some of them gave feedback on their experience after completing the session.

The time partners dedicated to the Driver Pilots 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 behavioural disorders, attention deficit and physical conditions.

The following summarizes the execution of the driver pilots in the different countries:

5.1.1 UK

5.1.1.1 University of Nottingham – UoN and Nottingham Trent University

UoN and NTU carried out the Driver Pilots at Oak Field School in Nottingham. In total eight students aged 10 to 18 were involved. The equipment that the school had did not meet MaTHiSiS requirements, and therefore, the pilots were carried out using a laptop provided by NTU and a NAO robot provided by UoN. Due to the particular needs of the pupils, the pilots were organised in a separate room at the school in which they would feel comfortable interacting with the system, and that made easier to avoid distractions from other pupils and/or interruptions. An introduction of what MaTHiSiS would do and how they had to interact with the system (in that case with the NAO robot) was given to the students, and more detailed instructions about each specific activity were also given to them. Overall, students enjoyed the experience and were very enthusiastic about interacting with the NAO robot and taking part on the different activities. A teacher or teaching assistant familiar with each pupil was present throughout the pilots and, along with the research

team, guided the students through the activities. Each session lasted between 15 and 35 minutes, and while the aim was to hold two sessions with each student, due to time limitations, it was only possible to do it with two of them. After every session every pupil was asked about their experience and some of them were able to give feedback.

UoN also organised the Driver Pilots to take place at Nethergate School in Nottingham. A total of four students were involved in the process, although it was not possible to carry out the scheduled sessions due to technical issues and time limitations. As Oak Field School, the equipment that Nethergate School had did not meet MaTHiSiS requirements, and therefore, the pilots were organised to be carried out using a laptop provided by NTU and a NAO robot provided by UoN.

5.1.1.2 **University of East London - UEL**

RIX@UEL organised a number of Driver Pilot sessions at the Charlton Park Academy. Eight students were involved aged 11 to 14. The venue was equipped with the required MaTHiSiS instruments (Laptop, Kinect v2, and IWB) and the environment prepared in such a manner that students were comfortable and accommodated. For example, those using a wheelchair had enough space in the room to manoeuvre.

The system was set up and awaited the arrival of each student. Each student were greeted on entering the room. A member of the research team who leads the pilot from the School's side, told each student what they would be doing and the part they would play in the driver pilot test. After each introduction, the equipment and system was activated by another RIX research team member.

Students were generally enthusiastic to participate. Each student were supported in a number of ways. For example, holding the tablet close to the student's face (those visually impaired) and/or placing them close to the IWB, taking their fingers and touching the pictures on the tablet and IWB to make it move as required, reading and or pronouncing words unfamiliar to students then allowing them to match those with pictures, asking students to attempt to read words on their own and giving opportunity for more able students to carry out the exercise without assistance.

Each student was engaged with the system for approximately 10 - 20 minutes each. Each pupil and accompanying teacher/teacher assistant were also invited to share their opinion about the system.

5.1.2 Italy

5.1.2.1 **Polo Europeo della Conoscenza - PE**

PE organised the Driver Pilots in two different venues: a private centre offering specialist support to disabled children and a public school enrolling special needs students within the mainstream classes. A total of four disabled learners aged 7 to 19 were involved in the Driver Pilot phase.

The teachers and practitioners were involved early in the project and in January 2017 they received a first introduction to the functionalities of the MaTHiSiS system. They built the Learning Graph for the pupils considering their educational needs and the social inclusion within the mainstream class: for these reasons in two cases the LG was the same as the rest of the class, in one the emotional awareness was the most important goal and in the most severe case the basic educational skills were strengthened .

The venues were equipped with the required materials and Platform Agents (laptop, HD web camera, Kinect v2, 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 or the activities of the centre.

The piloting period was mainly during the last two weeks of school, it was possible to have only one session per pupil.

5.1.2.2 **La Cometa del Sud**

LCS organized the pilots on one site, the primary school I Circolo Dicattico at Cava de' Tirreni. Seven PLMD children aged 6 to 12 were involved. The pilot implementation venue was a computer

laboratory with twelve computer working stations. The project and the pilot objectives were presented to the pupils underlining their active role in the experiment and the importance of its purposes. Information concerning concrete pilot activities were also provided to the teachers and the kids which enjoyed the tests. Tutors assisted the teachers throughout the duration of the pilots taking care in particular the relationship with teachers and children. The pupils, mostly attending the same class, came in pairs 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 ideas and impressions between both students and tutors and between the two children involved in the pilot.

5.1.3 Spain

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

JCYL organised Driver Pilots in two different venues, both from the public educational network, one is an infant and primary school with learners from 3 to 12 years old, some of them (on average two per classroom) with different disabilities together with other learning difficulties that are included in mainstream classrooms and the other venue is an Special Education School, with students from 5 to 21 years old, all of them with severe Profound and Multiple Disabilities. A total of eight learners were involved in the Driver Pilot phase. Most of the teachers from these venues were involved in the project since the first phase of the development of the different Learning Graphs. Both venues had computers, IWB and tablets and JCYL provided them with a NAO robot , Kinect v2 and some tablets in the case of the schools that did not meet the technical requirements. Driver Pilots were held in two different sessions in June.

5.2 Stakeholders Involved

5.2.1 UK

University of Nottingham - UoN and Nottingham Trent University - NTU	
Number of tutors involved	3
Number of teachers involved	1
Number of students involved	8

Table 10: Stakeholders involved: Oak Field School

University of Nottingham - UoN	
Number of tutors involved	1
Number of teachers involved	1
Number of students involved	4

Table 11: Stakeholders involved: Nethergate School

RIX Research and Media - RIX	
Number of tutors involved	1
Number of teachers involved	1
Number of students involved	8

Table 12: Stakeholders involved: Charlton Park Academy

5.2.2 Italy

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

Table 13: Stakeholders involved: I.C. Leonardo da Vinci

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

Table 14: Stakeholders involved: Social Cooperative Il Mosaico

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

Table 15: Stakeholders involved: Primary school I Circolo Didattico

5.2.3 Spain

Consejería de Educación – Junta de Castilla y León - JCYL	
Number of tutors involved	3
Number of teachers involved	4
Number of students involved	7

Table 16: Stakeholders involved: CEE "nº 1"

Consejería de Educación – Junta de Castilla y León - JCYL	
Number of tutors involved	3
Number of teachers involved	2
Number of students involved	1

Table 17: Stakeholders involved: CEIP "Gonzalo de Berceo"

5.3 Users Characteristics, Physical, Social, Learning Environment

5.3.1 UK

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

Organisation Name	*Oak Field School and Sports College*
Duration of the sessions	15-35 minutes per session
Number of sessions	Completed: 1 with 2 students and 2 with other 2 students
Description of physical environment	Sessions took place in a room at the school with two desks and chairs. On one of the desks the laptop running MaTHiSiS and the NAO robot were placed, and the students would sit in front of the NAO.
Description of social environment	1 x teacher/teaching assistant, 1 x researcher from UoN, 1 x student
Description of learning environment	Sessions were set up in a separate room. A researcher, the teacher/teaching assistant and the student were the only people in the room. The room was a well illuminated quiet room next to the student's classroom, and the equipment was set on a desk giving enough space for the student to interact with the NAO robot. The student was sitting down in a comfortable office chair in front of the robot. Since the teacher and teaching assistant were not familiar with the NAO and MaTHiSiS, they asked the researcher to lead the session, and they were giving support and prompting the student when required. All students needed to see at first how to interact with the NAO robot and to be prompted to continue with the activities.
Teachers involved (number and subjects)	1 SEN teacher and 2 SEN teaching assistants
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	8 learners 10-18 years old. ASC and PMLD students. All of them with intellectual disabilities ranging from mild to severe. Most of them with complex communication needs and skills, and difficulties with social interactions and understanding expectations. All students needed prompting and stimulation to capture and sustain attention during the sessions.

Table 18: Users Characteristics, Physical, Social, Learning Environment: Oak Field School and Sport Centre

Organisation Name	*Nethergate School*
Duration of the sessions	0 minutes per session
Number of sessions	0 - No sessions could start due to technical issues
Description of physical environment	Sessions were organised to take place in a separate room at the school with several chairs and tables. On one of the tables the laptop running MaTHiSiS and the NAO robot would have been placed, and the students would sit in front of the NAO.
Description of social environment	1 x teacher/teaching assistant, 1 x researcher from UoN, 1 x student
Description of learning environment	Sessions were organised to be set up in a separate room with a researcher, the teacher/teaching assistant and the student being the only people in the room. The room was a well illuminated room from the school and the students were familiar with the environment. There were tables available to

	set the equipment up, giving enough space for the student to interact with the NAO robot. The student would sit down in a comfortable office chair in front of the robot. Due to various technical issues and not being able to schedule further sessions when they were resolved no sessions could be completed.
Teachers involved (number and subjects)	1 SEN ICT teacher
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	4 learners 11-14 years old high functioning ASC and PMLD students. All of them with intellectual disabilities ranging from mild to severe. Some of them with complex communication needs and skills, and difficulties with social interactions and understanding expectations.

Table 19: Users Characteristics, Physical, Social, Learning Environment: Nethergate School

5.3.1.2 –University of East London - UEL

Organisation Name	*Charlton Park Academy*
Period of the sessions	10 - 20 min sessions per students
Number of sessions	3
Description of physical environment	Sessions took place in an IT lab suite - IT lab - one laptop computer setup and connected to an interactive whiteboard. Access to a tablet.
Description of social environment	1 technical assistant, 2 university researchers, 1 teacher, 1 student at a time.
Description of learning environment	The learning environment is one in which students are supported to accomplish goals and those more able, encouraged to carry out task independently. The use of technologies features prominently in this learning environment and students are encouraged and supported by staff in the use of these technological aids to learning. All staff are trained to use existing technologies and are experienced in using and supporting students to use existing hardware and software.
Teachers involved (number and subjects)	1 - SEN teacher
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	The 8 students who took part in the PMLD cases are young people between the ages 11-14. They have Profound and Multiple Learning Disabilities diagnosis. All of the students have complex communication needs.

Table 20: Users Characteristics, Physical, Social, Learning Environment: Charlton Park Academy

5.3.2 Italy

5.3.2.1 Polo Europeo della Conoscenza - PE

Organisation Name	*I.C. Leonardo da Vinci*
Period of the sessions	10 to 20 minutes
Number of sessions	1 session per learner
Description of physical environment	Dedicated room with laptop, NAO robot, Kinect v2, high resolution web camera, tablets, internet connection
Description of social environment	2 teachers, 2 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 years old girl with hemiparesis, severe cognitive delay, learning difficulties, language delay - 7 years old boy with cognitive delay and visual impairment, language difficulties

Table 21: Users Characteristics, Physical, Social, Learning Environment: I.C. Leonardo da Vinci

Organisation Name	*Social Coopertive Il Mosaico*
Period of the sessions	10 to 20 minutes
Number of sessions	1 session per learner
Description of physical environment	Dedicated room with laptop, Kinect v2, high resolution web camera, tablet, internet connection
Description of social environment	1 pedagogist, 2 students, 1 tutor
Description of learning environment	The students involved are 12 and 19 years old boys attending the secondary school. The driver pilot occurred in the after school centre.
Teachers involved (number and subjects)	1 clinical pedagogist
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	- 12 years old boy with cerebral palsy, developmental delay and behavioural disorder, fine and gross motor skills difficulties. - 19 years old boy with tetraparesis outcome from cerebral palsy , severe cognitive delay, partial use of right hand, poor vocabulary, short attention span.

Table 22: Users Characteristics, Physical, Social, Learning Environment: Social Cooperative Il Mosaico

5.3.2.2 La Cometa del Sud - LCS

Organisation Name	*Primary School I Circolo Didattico Cava dei Tirreni*
Period of the sessions	10-25 minutes
Number of sessions	1 session
Description of physical environment	Dedicated room with Hi-tech LAB with laptop, Kinect v2, webcam, tablet, internet connection
Description of social environment	1 teach, 7children, 3tutors
Description of learning environment	The students involved are aged between 6and 12. The learning environment to achieve the goals is based on the constructive relationship between the teacher and the child, encouraged to carry out an independent activity. The teacher's ability was to stimulate motivation and commitment and encourage

	collaborative learning.
Teachers involved (number and subjects)	1 - SEN teacher
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	- 1 child with learning disorder, language and communication disorders, behavioural disorders and attention deficit. - 10 years old child with cognitive and global development delay, language, communication and attention deficits. - 12 years student with a significant cognitive delay, behavioural disorders, attention deficit and language and communication disorders, selective mutism. - 6 year old child with visual impairment. - 7 year old child with cognitive delay, learning difficulties and language, communication and attention deficits. - 10 years child with cognitive delay, behavioural disorder, attention deficit and limited language. - 7 year old child with behavioural disorder and physical-motor disabilities.

Table 23: Users Characteristics, Physical, Social, Learning Environment: Primary School I Circolo Didattico

5.3.3 Spain

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

Organisation Name	*CEE "Nº 1"*
Period of the sessions	20 minutes
Number of sessions	1 session per learner
Description of physical environment	4 SEN, 7 children, 3 tutors, 1 technician
Description of social environment	Dedicated classroom with laptop, computers, NAO robot, Kinect v2, high resolution web camera, tablet, internet connection.
Description of learning environment	Learners are in classrooms with maximum 5-8 pupils
Teachers involved (number and subjects)	4 SEN
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	- Male, 5 years old. Moderate intellectual disability, X fragile syndrome, language delay, specific learning difficulties on writing, maths and reading and writing - Female, 7 y.o. Moderate intellectual disability, physical disability, Dysphasia, specific learning difficulties on writing, maths and reading and writing. - Male, 8 y.o. Moderate intellectual disability, physical disability with affectation in motor functions and generalized hypotonia; visual impairment and dysphasia. - Female, 16 y.o. Moderate intellectual disability, significant language and communication disorder, specific learning difficulties on writing, maths and reading and writing. - Male, 16 y.o. Moderate intellectual disability, physical disability with affectation in motor functions, visual impairment and dysphasia. - Male, 12 y.o. Moderate intellectual disability, visual impairment, communication disorders (only communicative by signs), specific

	learning difficulties on writing, maths and reading and writing. - Female, 15 y.o. Moderate intellectual disability and aphasia

Table 24: Users Characteristics, Physical, Social, Learning Environment: CEE "nº 1"

Organisation Name	*CEIP "Gonzalo de Berceo"*
Period of the sessions	25 minutes
Number of sessions	2
Description of physical environment	1 SEN, 1 teacher (primary school), 1 pupil,, 3 tutors, 1 technician
Description of social environment	Dedicated classroom with laptop, computers, NAO robot, Kinect v2, high resolution web camera, tablet, internet connection.
Description of learning environment	Pupil that participated in the driver pilot is included in a mainstream classroom that will be added as a venue for MEC next pilots
Teachers involved (number and subjects)	1 SEN, 1 teacher primary school level
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	- 12 years old pupil with Down syndrome, light stuttering (dysphemia), specific learning difficulties on mathematics, reading and writing.

Table 25: Users Characteristics, Physical, Social, Learning Environment: CEIP "Gonzalo de Berceo"

5.4 Learning goals, Smart Learning Atoms, Learning Materials

5.4.1 Learning Goals and Smart Learning Atoms

5.4.1.1 **UK**

University of Nottingham - UoN and Nottingham Trent University - NTU

Learning goals, SLAs and Learning Actions		
Age 7-18		
Learning Goal	**SLA**	**Learning Action**
Navigation	Left and right identification	Identify left and right (own/object)
		Recognise left and right direction
		Turn left and right
	Area recognition	Match name or symbol to different rooms
		Identify location of different places on map/model
	Targeted location navigation	Walk/navigate to find location
Sequencing	Sorting	Sort objects into right order
		Sort ascending / descending on one dimension e.g. height, number in group

	Order of events	Sort pictures into logical order e.g. child waking up, dressing, eating breakfast, leaving house. Identify incorrect sequences
		Sort words in sentence into logical order. Identify incorrect order.
Vocabulary (improvement)	Object recognition	(Correctly) point to picture of object named by tutor, being given an increasing number of objects to choose
		Match written name to picture being given an increasing number of objects to choose from
		Play Fish or pairs game
	Action words recognition	(Correctly) point to picture of action named by tutor, being given an increasing number of actions to choose
		Play Fish or pairs game
	Descriptor words recognition	(Correctly) point to picture of descriptor (e.g. big, yellow, hairy) named by tutor, being given an increasing number of descriptors to choose
		Play Fish or pairs game
	Pronunciation (improvement)	Repeat name of object/action/colour spoken by robot

Table 26: Learning graph: Oak Field School and Sports College and Nethergate School

University of London -

Learning goals, SLAs and Learning Actions		
Age 11-14		
Learning Goal	**SLA**	**Learning Action**
Understand cause and effect	Select a particular area on the screen.	Locate a particular area of the screen
		Locate an image to select
	Recognise that my action will make my video play.	Touch to activate video (press and release)

Table 27: Learning graph: Charlton Park Academy

5.4.1.2 **Italy**

Polo Europeo della Conoscenza

Learning goals, SLAs and Learning Actions		
Age 6 years old		
Learning Goal	**SLA**	**Learning Action**
Improve motor skills	Motor sequencing and spatial coordination	Repeat/imitate sequences
Improve	Synonyms / antonyms	Find synonyms

vocabulary		Find antonyms
	Semantic fields establishment (conceptual networks)	Connect words about one semantic field
Improve social skills	Emotional awareness	Identify emotional facial expressions
		Demonstrate understanding of different emotions

Table 28: Learning graph: I.C.Leonardo da Vinci

Learning goals, SLAs and Learning Actions		
Age 12 years old		
Learning Goal	**SLA**	**Learning Action**
Improve emotion expression skills	Emotional awareness	Identify emotional facial expressions
		Demonstrate understanding of different emotions
	Eye contact	Make eye contact with different facial expression
	Imitation	Imitation
	Basic emotion recognition	Say emotions
		Classify emotions
	Basic emotion expression	Play "Emociómetro" activity

Table 29: Learning graph: Social Cooperative Il Mosaico 1

Learning goals, SLAs and Learning Actions		
Age 19 years old		
Learning Goal	**SLA**	**Learning Action**
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 Vocabulary	Object recognition	Point to picture of object named, being given an increasing number of objects to choose
	Action words recognition	Point to picture of action named by tutor, being given an increasing number of actions to choose
	Descriptor words recognition	Point to picture of descriptor (e.g. big, yellow, hairy) named by tutor, being given an increasing number of descriptors to choose
Navigation	Left/right identification	Turn left and right

Table 30: Learning graph: Social Cooperative Il Mosaico 2

La Cometa del Sud - LCS

Learning goals, SLAs and Learning Actions		
Age 6 - 10 years old		
Learning Goal	**SLA**	**Learning Action**
Improve attention skills	Visual attention	Ability to follow and repeat a section of notes on a piano
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 cognitive and strategy skills	Activate strategies to increase resolution speed	To feed the cookie monster
		Recognize and remember the same images
Improve math skills	Number- quantity	Associate a number with a quantity
		Put numbers in order ascending or descending

Table 31: Learning graph: Primary School "Primo Circolo Didattico"

5.4.1.3 **Spain**

Consejería de Educación – Junta de Castilla y León - JCYL

Learning goals, SLAs and Learning Actions		
Ages 8-12 years old		
Learning Goal	**SLA**	**Learning Action**
Impove emotional skills	Emotional awareness	identify emotional facil expressions
		demonstrate understanding of different emotions
	being able of stablishing eye contact	make eye contact with an animated target
		make eye contact with different facial expressions
	Imitation	Imitate facial expressions
		imitate body gestures
	Basic emotion recognition	say emotions
		classify emotions

Table 32: Learning graph: CEE "Nº 1", CEIP "Gonzalo de Berceo"

5.4.2 Learning Material

5.4.2.1 **UK**

University of Nottingham - UoN and Nottingham Trent University - NTU

The Learning Materials used during the Driver Pilots were a series of behaviours developed for the NAO robot compliant with the proposed SLAs and LGs. The following LMs were used:

- LM_action2card. The NAO robot says an action and asks the student to show it the card with the relevant action.
- LM_findlocation. The NAO robot asks the student to direct it to a location that will be

marked with a card.

- LM_object2card. The NAO robot says the name of an object and asks the student to show it the card with the relevant object.
- LM_repeatword. The NAO robot says a word and asks the student to repeat it.
- LM_rightorleftdirection. The NAO robot asks the student to move it right or left.
- LM_rightorlefthand. The NAO robot asks the student which hand it is raising.
- LM_room2card. The NAO robot says the name of a room and asks the student to show it the card with the relevant room.
- LM_sortingcards. The NAO robot asks the student to sort a logical sequence of images in the correct order.
- LM_sortnumbercards. The NAO robot asks the student to show it the card with a number higher or lower than a given one.
- LM_sortwordcards. The NAO robot asks the student to sort the words of a sentence in their logical order.
- LM_turnleftorright. The NAO robot asks the student to turn it right or left.
- LM_word2card. The NAO robot says a word and asks the student to show it the card with the relevant word.

RIX Research and Media - RIX

At the Charlton Park Academy driver pilot Interactive white board, tablet and a laptop were used. There were other learning materials used, namely: pictures and symbols.

One of the symbols included in the Learning material was the symbol of the RIX Wiki. RIX Wiki is a self-advocacy tool used in the school by all pupils. The aim is to give learners with profound and multiple learning disabilities means to request to view their own RIX Wiki. To achieve this, students need to be able to make the association between the RIX Wiki Picture or Symbol and the access to their own Wiki. The learning materials were created and organised in a step by step process that enabled students to achieve these goals.

Firstly, the learning materials required students to be able to recognise symbols, objects and/or pictures. Secondly, students were required to locate and select symbol, objects and/or picture on the tablet and IWB to get them to spin and/or move. Thirdly, they were required to recognise and select the RIX Wiki symbol so as to activate their RIX Wiki with the help of the teacher. By engaging in this step by step process, student came to recognise that their action caused an effect.

5.4.2.2 Italy

Polo Europeo della Conoscenza

At the I.C Leonardo da Vinci Bussolengo the PA used were the NAO robot and tablets.

- LA repeat/imitate gesture: The NAO robot performs some movement and asks the children to repeat the sequence of gestures.
- LA find synonyms: The NAO robot asks to identify the synonym of a word among the suggested ones.
- LA find antonyms: The NAO robot asks to identify the antonym of a word among the suggested ones.
- LA Connect words about one semantic field: The NAO robot which asks to pronounce a word linked to a given topic.

- LA Identify emotional facial expressions: The NAO robot ask the pupil to identify and show one emotion (neutral, angry, happy, sad, disgusted, scared).
- LA Demonstrate 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.

At the social cooperative Il Mosaico the PA used was the tablet.

- LA Identify 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 Demonstrate understanding of different emotions: The app in the tablet shows 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 associate a number with a quantity: The app in the tablet display a number of dots and ask about the number.
- LA Put numbers in order (ascending/descending): On the screen there are numbers in a random order, the pupil has to order these numbers correctly.
- LA Identify the largest / smallest number between two numbers: The system displays two different numbers and asks the pupil to indicate which is the largest/smallest (alternating or randomly); the pupil has to click/tap on which is the correct number.
- LA point to picture of object named: Matching game either shown written word (or spoken word) and has to select correct picture from those below or shown all words and has to pair each one with correct picture.
- LA point to picture of action named: Matching game either shown written word (or spoken word) and has to select correct picture from those below or shown all words and has to pair each one with correct location picture.
- LA point to picture of descriptor named: Matching game either shown written word (or spoken word) and has to select correct picture from those below or shown all words and has to pair each one with correct picture.
- LA turn left and right: Move character round 2D maze with simple commands or tapping arrow on screen. Maze can become more complex.

La Cometa del Sud - LCS

At the Primary School I Circolo Didattico Cava dei Tirreni the pilots were realized using PCs and tablet:

- LA Follow and repeat a section of notes: On the tablet, the pupil was displaying the piano and the sequence of the keys that were repeated. The child should be able to store the sequence and restore it.
- LA Building a 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 image. In case of success it passes from a jigsaw puzzle of four tiles to a more difficult level by increasing the number of tiles.
- LA Identify 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 Active strategies to increase resolution speed: The child looks at the image of a cartoon monster and depending on the movement of this monster cookie, he must move the food to eat it by activating speed and attention strategies.

- Memory: The child exercises by testing his memory trying to weave with the same picture depicted, the pilot increased the difficulty by increasing the number of tiles.
- LA Associate 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 put numbers in order (ascending/descending): The app in the tablet requires to put three numbers in ascending or descending order.

5.4.2.3 **Spain**

Consejería de Educación – Junta de Castilla y León - JCYL

At CEIP "Gonzalo de Berceo" and CEE nº 1, the PA used were tablets and NAO robot with the following LM:

- LA Count pictures: the app in the tablet requires to put choose among 3 numbers that corresponding to the number of pictures on the screen
- LA Associate 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 connect words about one semantic field: The NAO robot asks student to pronounce a word linked to a given topic (home, school, hospital…).
- LA Identify emotional facial expressions: The NAO robot ask the pupil to identify and show one emotion (neutral, angry, happy, sad, disgusted, scared)
- LA Identify a sound that corresponds to an emotion (laugh, crying,ecc): 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 University of Nottingham – UoN and Nottingham Trent University – NTU

Teachers and teaching assistants involved in the pilots had a positive overall vision of MaTHiSiS. They were very understanding regarding the technical issues that were present at some points, and knew that the version that they were using was a first version with a lot of room for improvements. Some of the comments or suggestions that they mentioned are:

- Rewards should be offered to the student when s/he performs well.
- Technical issues present in these pilots need to be solved for subsequent pilots.
- When a student gets an answer wrong s/he should always be given another chance, at least once. The best would be to be able to set a parameter in the system that dictates the number of opportunities that a specific student should be given.
- It would be nice and useful if the response time of the system could be also modified through a variable depending on the student.
- The instructions given by the robot need to be clearer in general.

6.1.1.2 University of East London - UEL

Teachers' comments were generally positive. For example, "The system seems a little more stable"; "The activities were right for the students"; "The system had a slight delay in response to the touch, but overall it worked". Suggestions for improvement include: the addition of sound or music in the activities to aid in keeping students' attention and making pictures larger, especially for those who are visually impaired.

6.1.2 Italy

6.1.2.1 Polo Europeo della Conoscenza - PE

The teachers involved collaborated actively with PE team during all the phases of the Driver Pilots.

Despite the specific training given to them, even 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 feedback 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 teachers reacted positively to the structure and were very interested by the future use of MaTHiSiS system.

Considering the disability and the difficulties of the PMLDC they would need to be aware of – or to see more clearly - the next Learning Activity that the Platform Agent is going to start in order to introduce it to the pupil or to pause the learning experience if the level of frustration or tiredness would increase during the exercise. It is needed also to identify the proper PAs considering the difficulties that the learners with PMLD encounter (physical and sensorial impairment) and the difficulty to identify the engagement through the gaze.

6.1.2.2 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. For the Assisted Pilots the teachers expressed the need for an easier set up set up of the system and a more stable version of the platform.

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 in case its user friendliness and its capacity to detect learners' affect state are improved

Rewards on both devices should be improved, in order for the students to receive feedback during their experience.

Considering the physical impairments of some users, certain devices are not adapted for them: learners with gross motor skills strongly affected can find challenging either to show pictures to the NAO and to touch the screen of the tablet on the point they should. Moreover, fonts, draws and numbers in the tablet were too small for the children with visual disabilities. NAO robots sometimes had not clear speech and were not able to interpret the pronunciation of some pupil. For the next phase of pilots a different PA or LM should be considered.

According to teacher's point of view, at this stage of technical development, passive sensors did not always interpret correctly the engagement, boredom or frustration of learners.

6.2 Learners perspective

6.2.1 UK

6.2.1.1 **University of Nottingham – UoN and Nottingham Trent University – NTU**

All students enjoyed the sessions and wanted to play with the NAO robot, although one of them told us that he was tired after the session. They could not give us complex feedback after the sessions, but they could let us know if they enjoyed and/or if they wanted to play again on another day.

Learners were all able to participate and interact with the robot well. However, some of the students needed assistance when they had to hold a card in front of the robot or move the robot using a tablet. Some students needed the teacher to explain the activities and what was expected from them several times, and some needed prompting during the whole session.

6.2.1.2 **University of East London - UEL**

While some students were unable to indicate whether or not they enjoyed working with the system and playing the games, others were able to with signs and gestures. For example, one student indicated both thumbs up and down when asked if she taught the games and activities were good. This could be interpreted as enjoyment of certain activities and non-enjoyment of others. Another student said, she liked the face game best and still another said that the games were good, but not as exciting as YouTube.

6.2.2 Italy

6.2.2.1 **Polo Europeo della Conoscenza - PE**

The teachers introduced the new setting and devices to the children, for those who worked with the NAO Robot was the first time, but the pupils reaction was quite 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 this peculiar Use Case.

6.2.2.2 **La Cometa del Sud - LCS**

In general, the pupils reacted to MaTHiSiS with curiosity and enthusiasm as this type of learning experience was new for them and very different from what they are used to; this brought a remarkable increase in attention. Only in one case the child could not complete the session and tend to close it almost immediately because it was attracted by the possibility of opening other sessions.

6.2.3 Spain

6.2.3.1 **Consejería de Educación. Junta de Castilla y León- JCYL**

Pupils are used to a tablet but for most of them it was the first time working with a NAO Robot, only one reacted with fear and wanted to go away from the classroom; the teachers decided to try a second time and the learner started to interact a bit with the robot.

Levels of difficulty were not adapted to all cases (in some cases even the easier level was too difficult), and it was not possible to adapt it in that moment (for instance there were learners that only know the differences between happy and sad but it was proposed “angry” “surprised”, “disgusted”, “neutral” (neutral for instance doesn't mean anything in Spanish).

Learner were not 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"[10]. 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/pmlddriverpilot .

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 25. 9 out of 25 answers were from observers, that is, people from the MaTHiSiS consortium who went in and ran the driver pilot sessions.

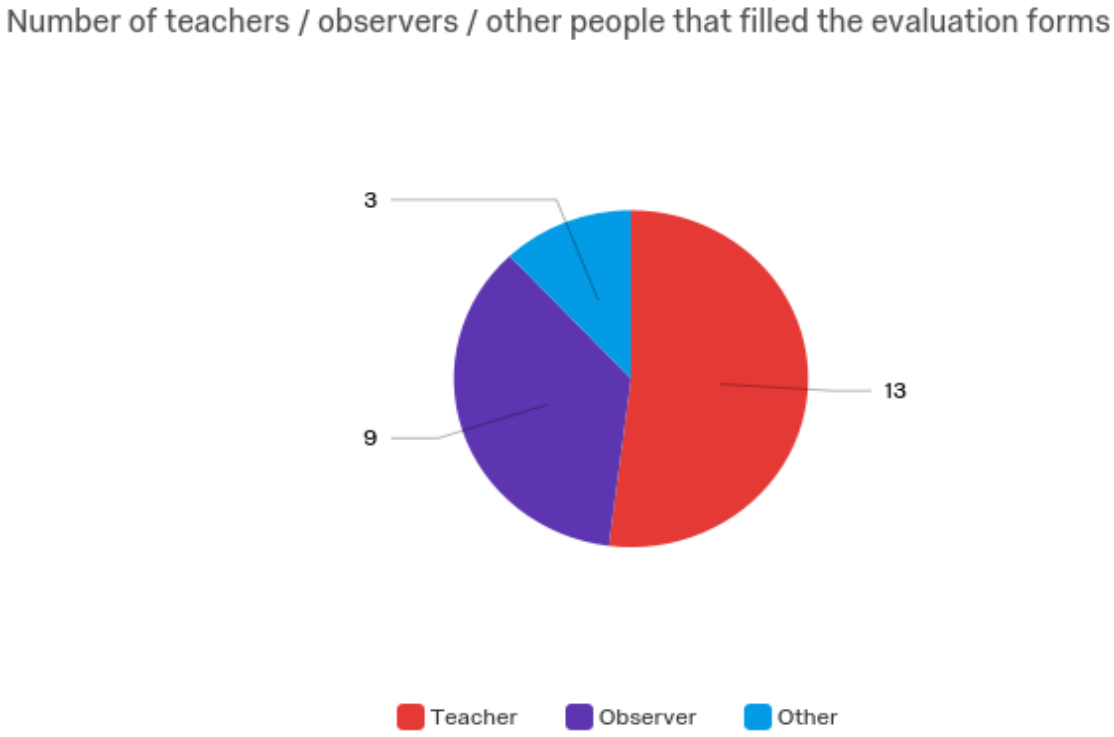

Figure 1: Stakeholders - Teachers / Tutors / Observers

7.3.2 Learners

The number of respondents to the survey from the student's perspective was 23. All 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.

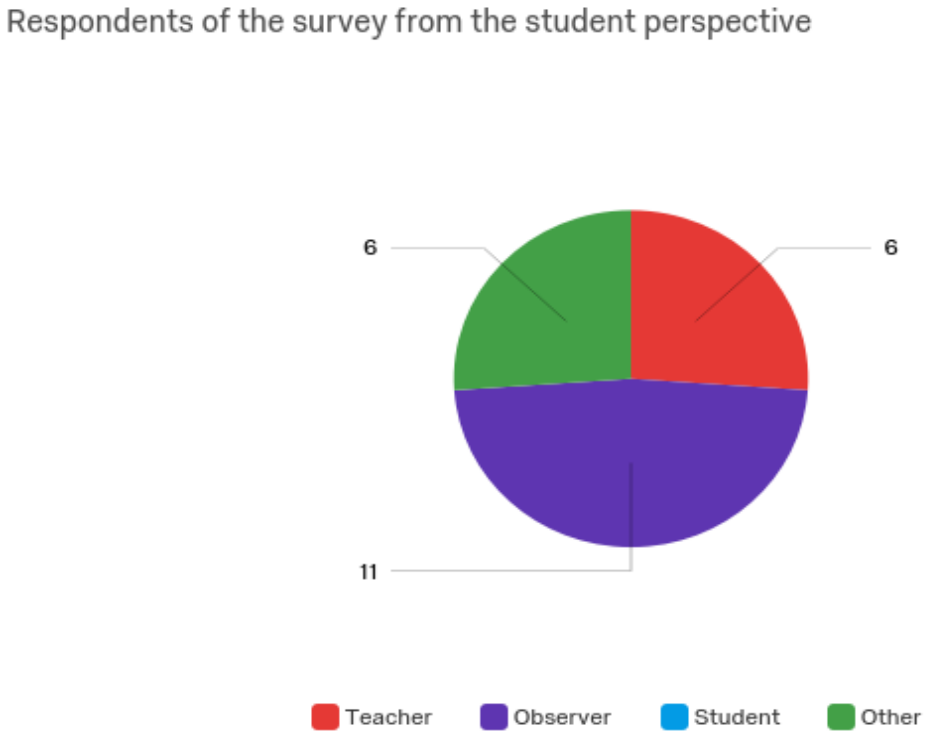

Figure 2: Stakeholders - Learners

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.

7.4.1.1 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.

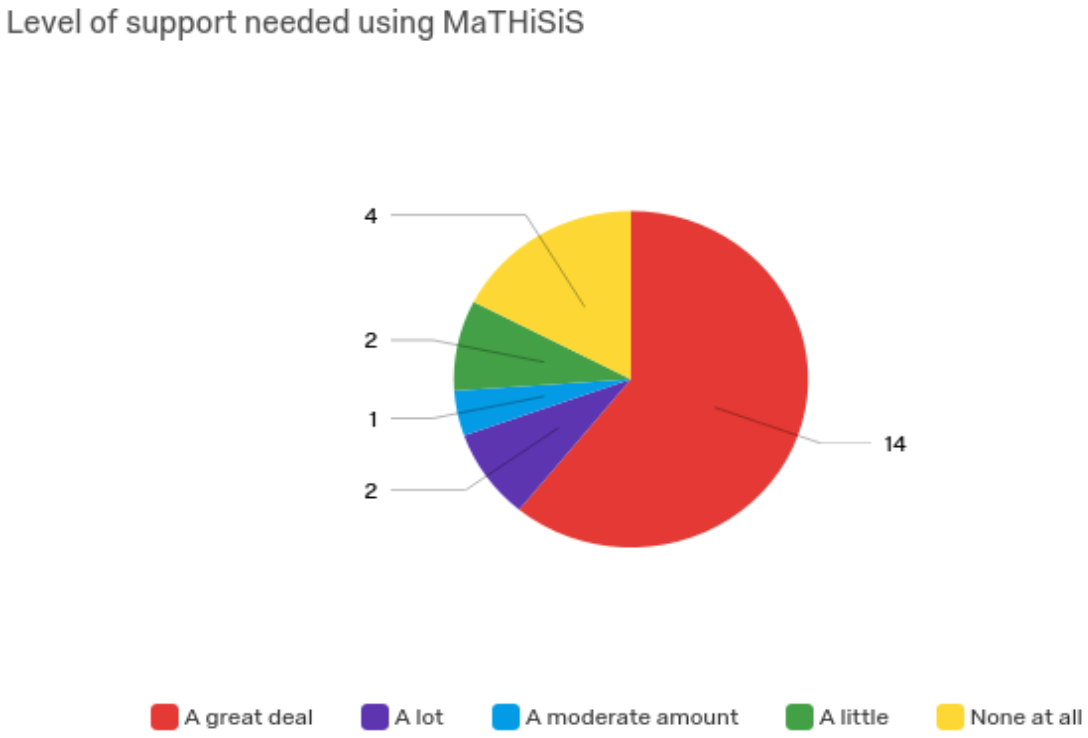

Figure 3: KPI 1 Usability: Teachers' perspective - Question 1

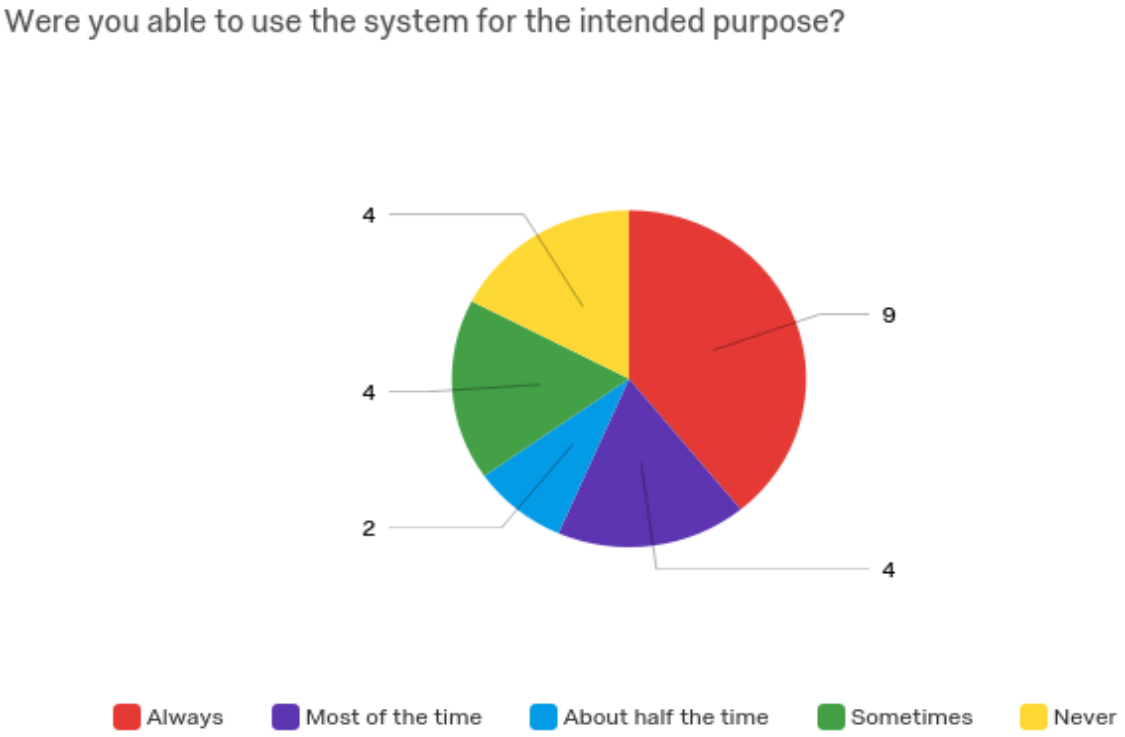

Figure 4: KPI 1 Usability: Teachers' perspective - Question 2

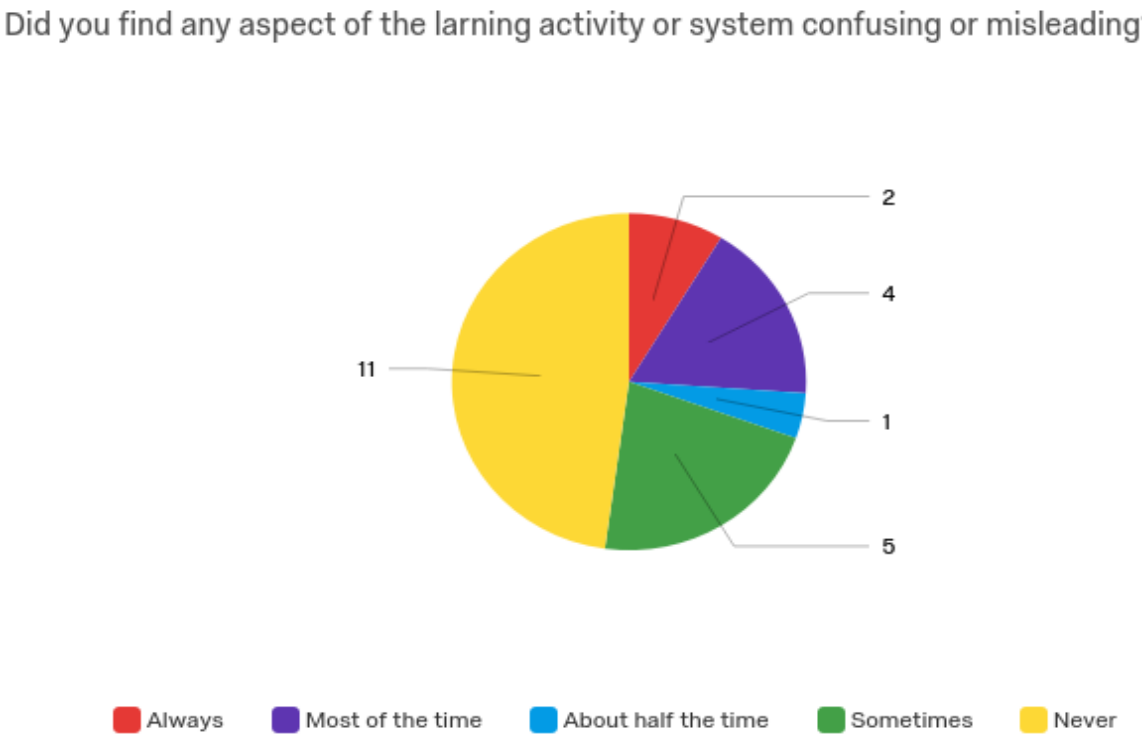

Figure 5: KPI 1 Usability: Teachers' perspective - Question 3

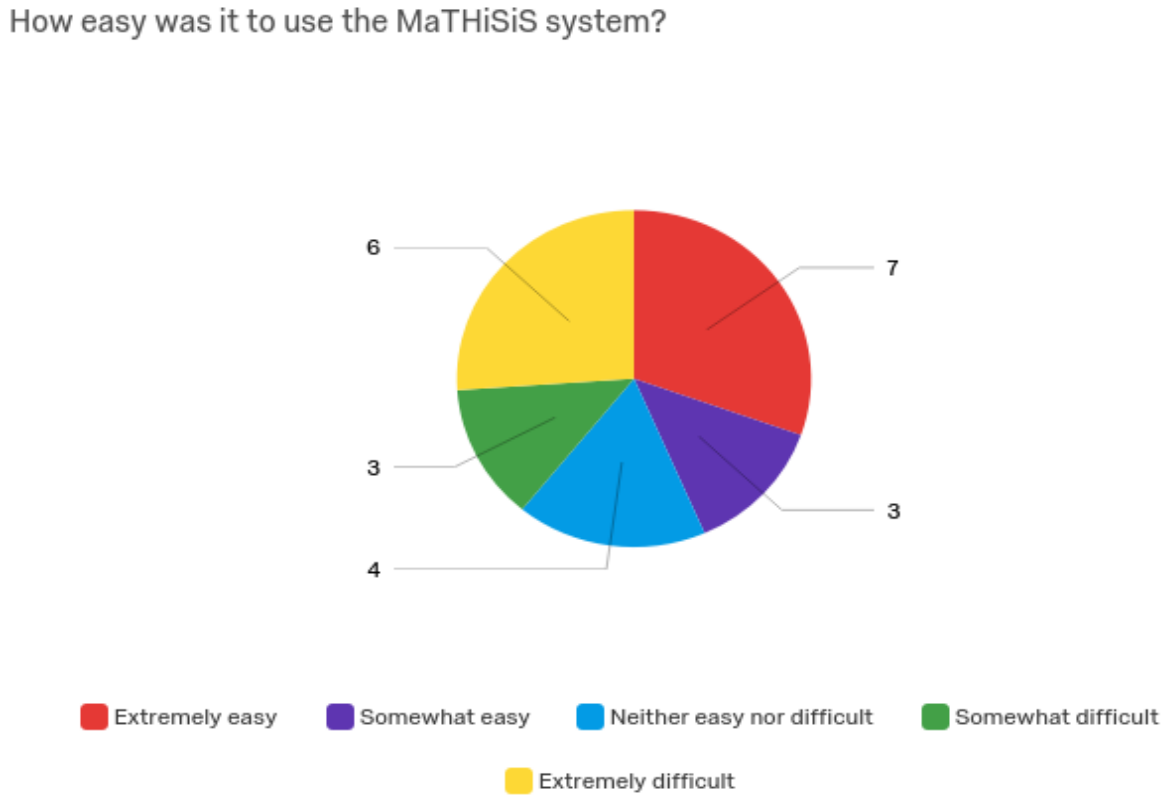

Figure 6: KPI 1 Usability: Teachers' perspective - Question 4

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 "were you able to use the system for the intended purpose", not all the respondents were always able to use the system for the intended purpose 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"[11], 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. However the majority of the respondents consider that the MaTHiSiS platform was easy to use.

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.

7.4.1.2 **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.

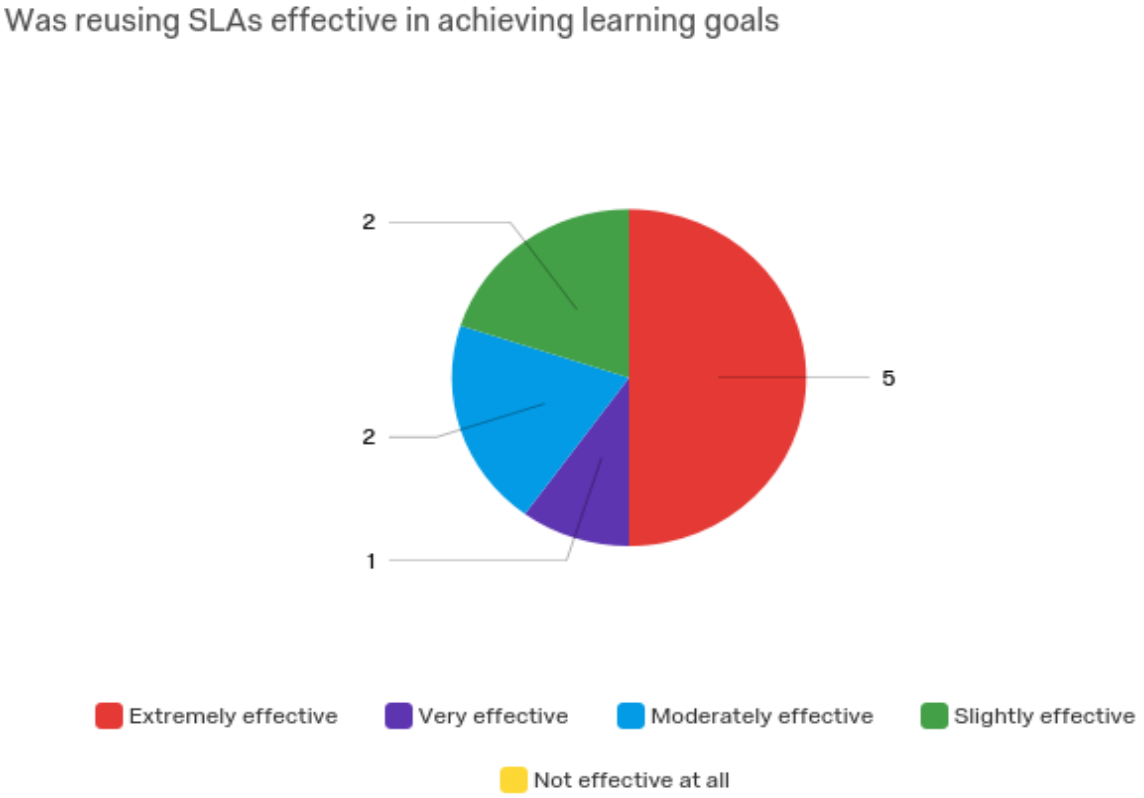

Figure 7: KPI 1 Usability: Learners' perspective - Question 1

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

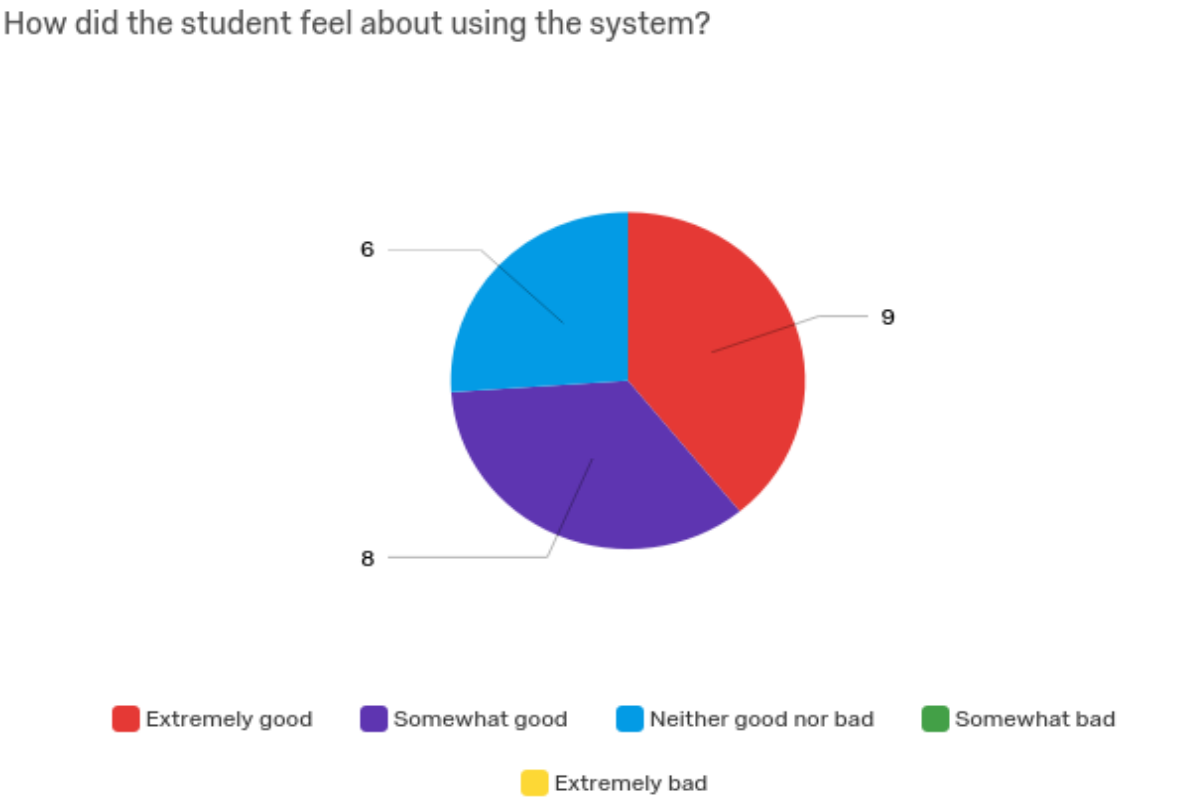

Figure 9: KPI 1 Usability: Learners' perspective - Question 3

Conclusions

The technical difficulties and set-up alignment mentioned in the previous section prevented in some cases, the learners from completing the learning experience process, thus achieving their personal goals. It is significant that, according to the responses, the majority of the learners found the interaction with it very pleasant.

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.

7.4.2.1 Teachers

Questions

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

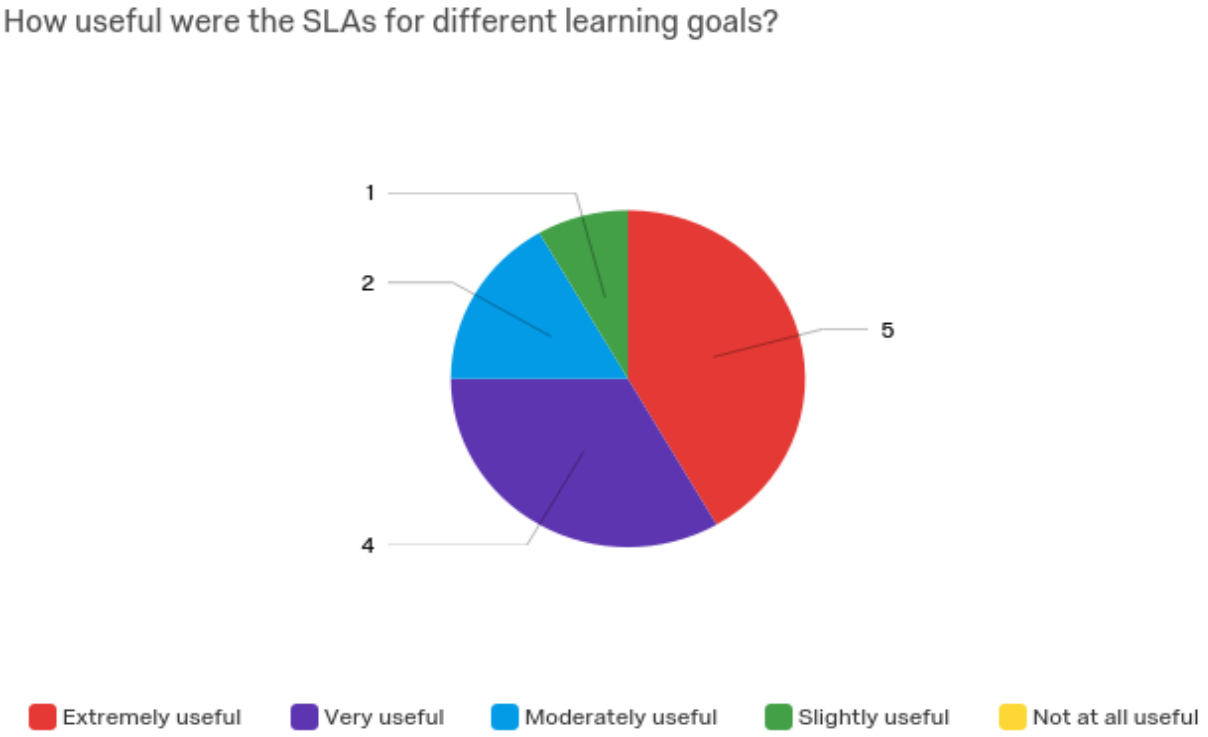

Figure 10: KPI 2 Reusability: Teachers' perspective - Question 1

The numbers in the pie chart indicate the number of teachers that voted for each answer.

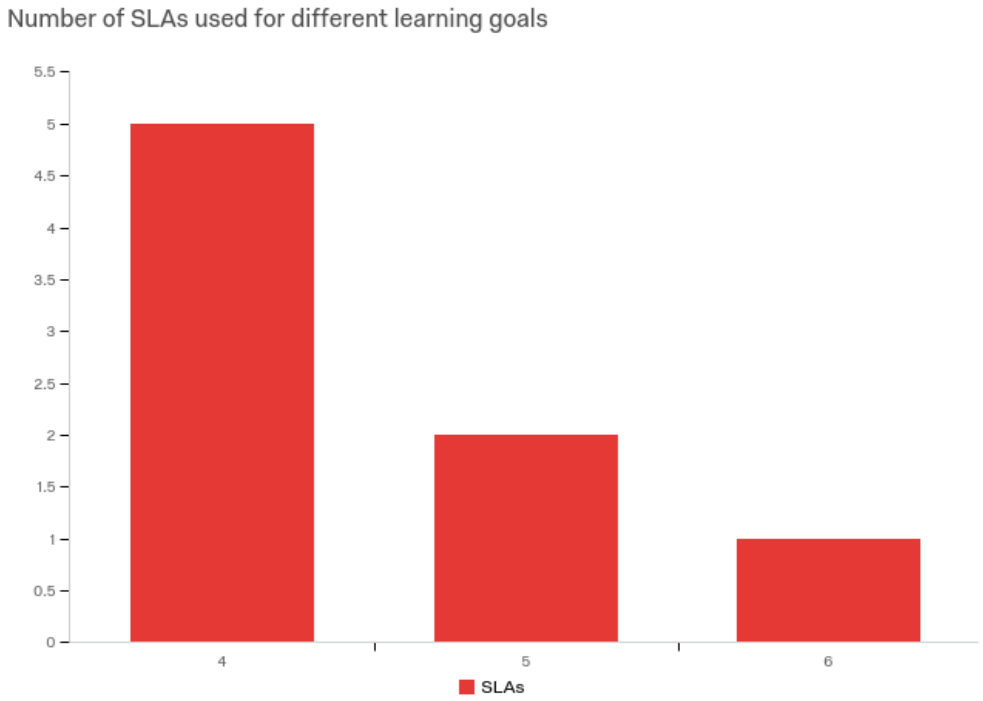

Figure 11: KPI 2 Reusability: Teachers' perspective - Question 2

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, 6 teachers used 1 SLA, 2 teachers used 5 SLAs and 5 teachers used 4 SLAs for different learning goals.

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 (LG) which is a strong attestation of the SLA concept's benefit to reusable learning content.

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.

7.4.3.1 Teachers

Questions

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

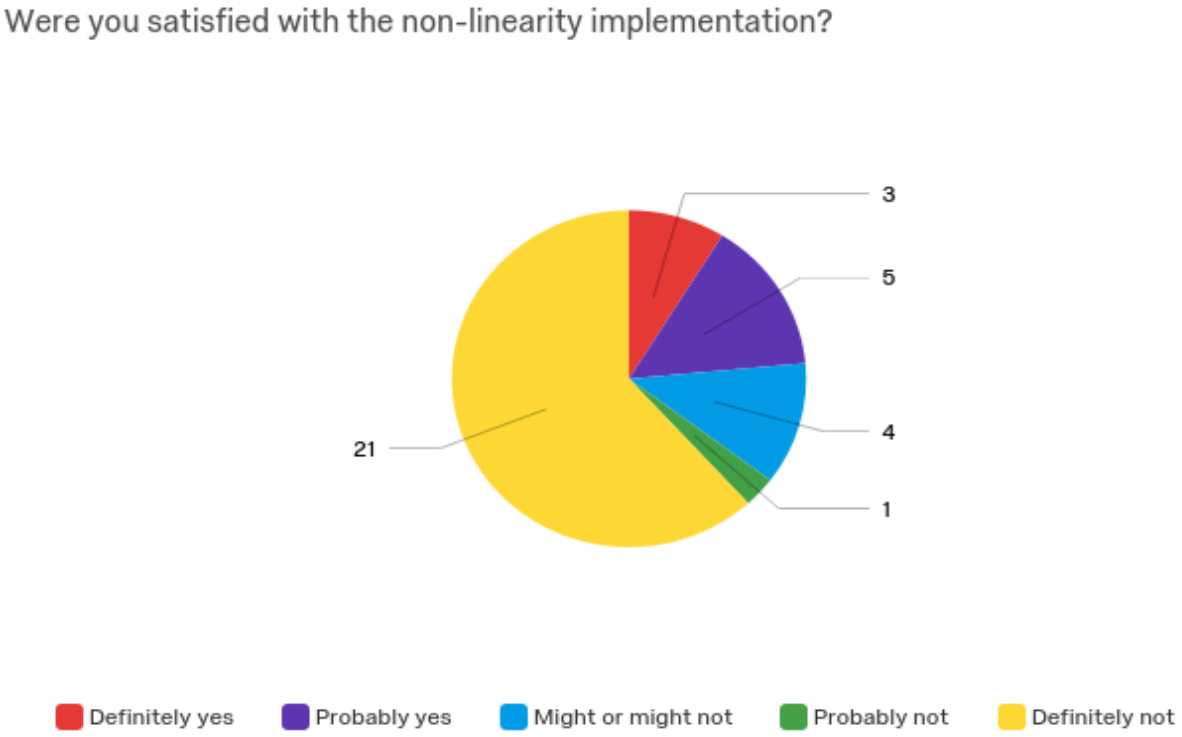

Figure 12: KPI 3 Non-Linearity: Teachers' perspective

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.

7.4.4.1 Teachers

Questions

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

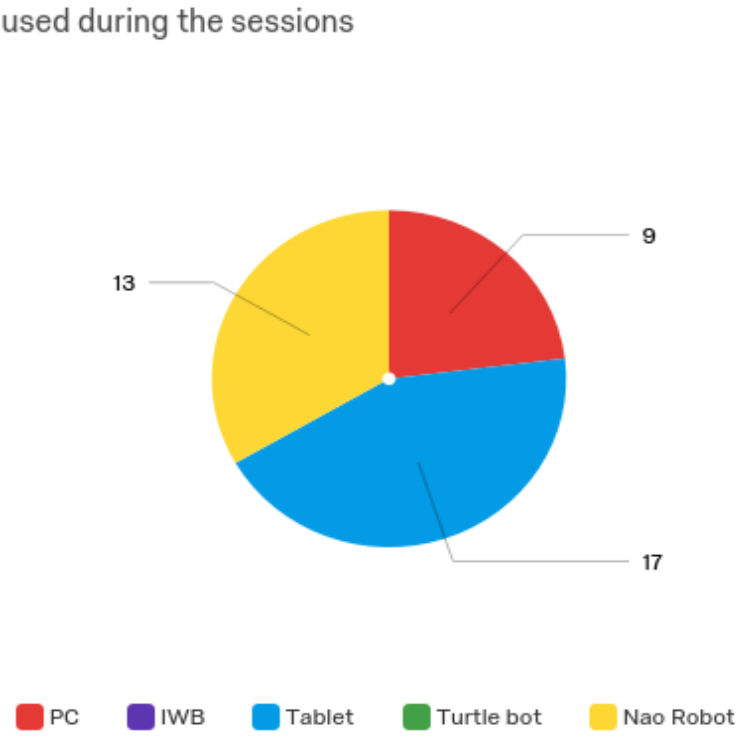

Figure 13: KPI 4 Accessibility: Teachers' perspective

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 it has been demonstrated that, robots can add value in the learning process. The IWB was not used in the driver PMLD 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.

7.4.4.2 Learners

Questions

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

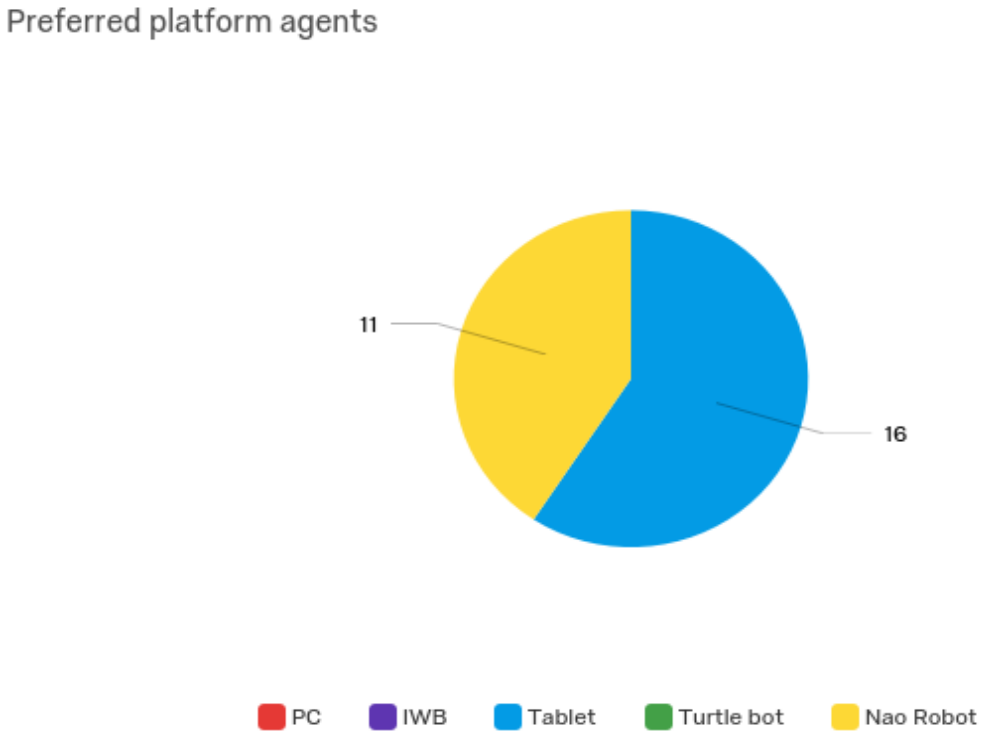

Figure 14: KPI 4 Accessibility: Learners' perspective

Conclusions

According to the responses, the tablet is the preferred agent for the ASC students, as this traditional device, is mostly available in the classrooms – and for this reason, and due to the familiarity with these PAs they were deemed easier to use. It is also apparent from the pie chart that NAO robots are in the second position of the list. It has been demonstrated that robots can comprise an added value in the learning process for children with educational needs.

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.

7.4.5.1 Teachers

Questions

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

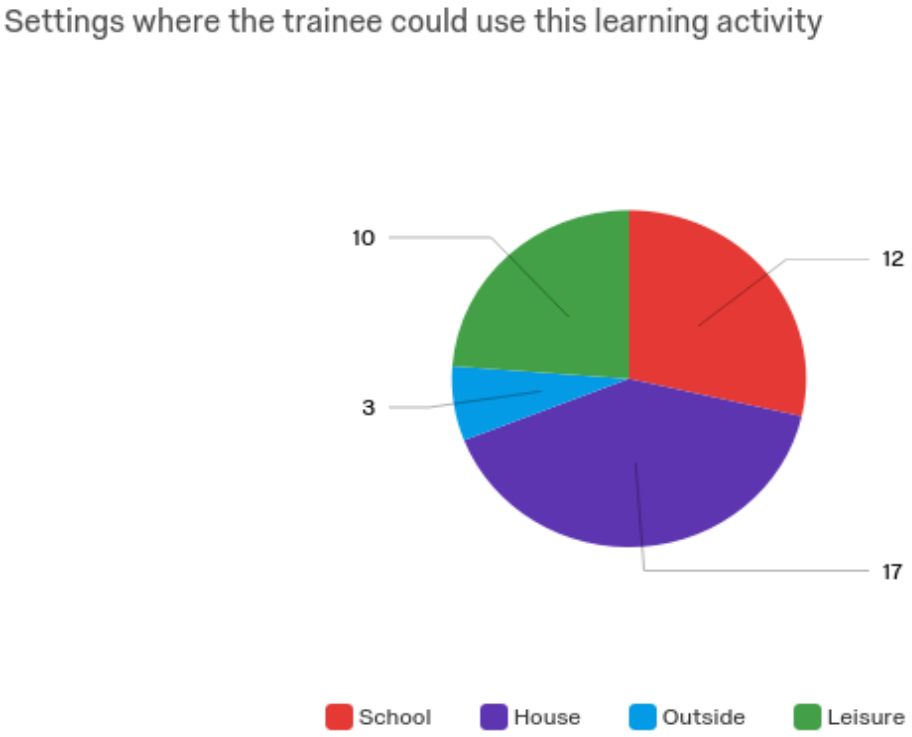

Figure 15: KPI 5 Ubiquity: Teachers' perspective

Conclusions

The majority of the participants indicated that the schools and home as the most suitable places to use the MaTHiSiS platform. 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 setting-up the system without external support, the non-availability of some of the platform agents at home (i.e. NAOs) and the requirements for the Internet connection. The former, regarding the setting-up 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, 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.

7.4.6.1 Teachers

Questions

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

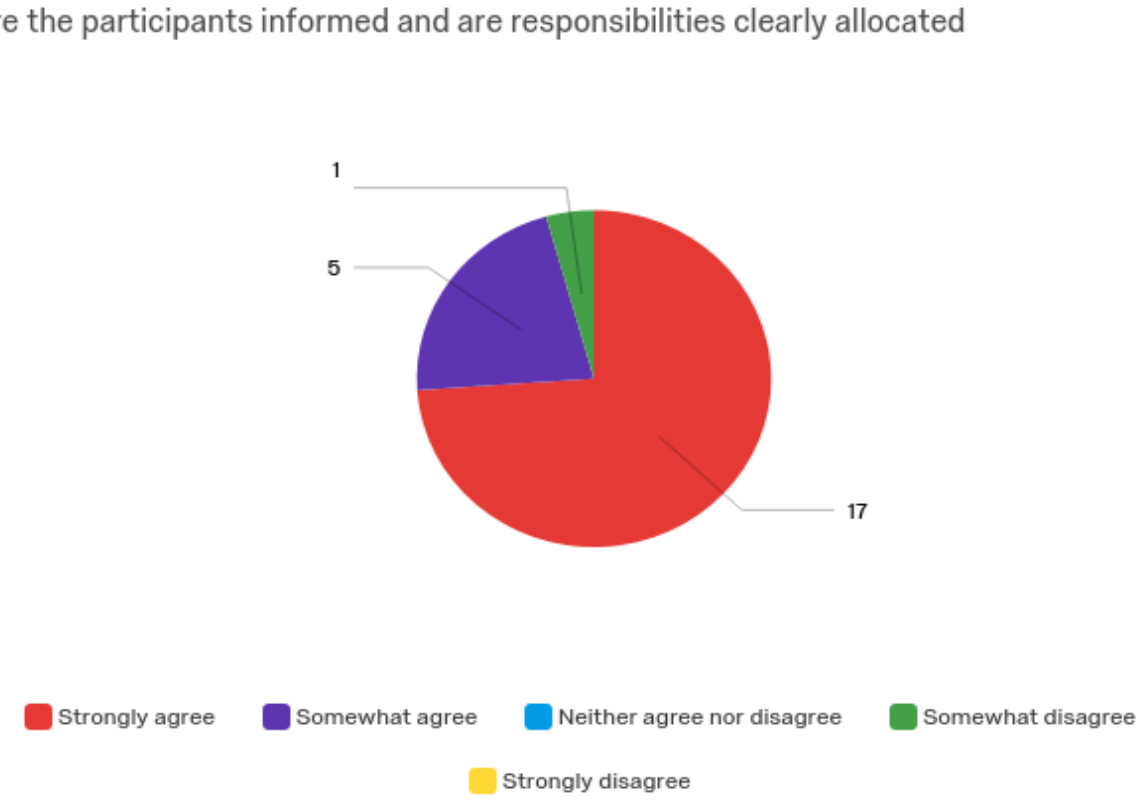

Figure 16: KPI 6 Ethical adherence: Teachers' perspective

The numbers in the pie chart indicate the number of teachers that voted for each answer.

Conclusions

The results obtained shows that the majority of the respondents had a clear view on their responsibilities.

Participants were also asked if they had any ethical concerns with the current use of the system and any extreme use cases (e.g. evoke distress, anxiety, anger or other negative effect, and if so, was the effect transient or persistent. None of them indicated ethical concerns. But what it is interesting is that some of them indicated that negative interactions with the platform agents (i.e crash of the system) can produce a persistent effect of refusal. The improvements to be done in the MaTHiSiS platform will solve the technical problems presented in the first version of the platform that may produce these effects in children.

8 Conclusion

This document describes the stages of implementation of the driver pilots in the Profound and Multiple Learning Disabilities 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 PMLD learners.

The Driver Pilots implementation could rely on the close collaboration of the end users. Since the first phase of development of the Learning Graphs, the teachers and the practitioners involved, realised the potential and the usefulness of the MaTHiSiS system for the daily teaching activity with PMLDC thanks to the student centred pedagogy, the affective state recognition and the adaptation and personalisation of the learning path. Especially for the PMLD students enrolled in the mainstream classes, MaTHiSiS system can represent a 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.

The PMLDC involve several complex conditions and situations that can be very different; 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, and the instructions should be more precise.

The main challenge connected to this UC is the interpretation of the affective state of the users and their level of engagement: it will be necessary to identify suitable PAs and sensors to obtain reliable data. The technical and pedagogical partners will also have to work jointly in order to improve the process of adaptation and personalisation of the LMs, for example in the cases of low fine motor skills or sensory impairments.

9 References

[1] Nottingham Trent University (ed.), D.2.1 Formation of the stakeholder group. Deliverable of the MATHISIS project, 2016

[2] Nottingham Trent Univerisity (ed), D2.2 Full scenarios for all use cases. Deliverable of the MATHISIS project, 2016

[3] Ware, J. (2004) *Ascertaining the Views of People with Profound and Multiple Learning Disabilities*, British Journal of Learning Disability, 32: 175–9.

[4] Tracy, J (2010) www.cddh.monash.org/assets/documents/intellectual-disability.pdf

[5] Bellamy, G., Root, E., Bush,A., Berry,H & Smith A, (2010) *A study to define: profound and multiple learning disabilities (PMLD) Journal of Intellectual Disabilities,* 233

[6] Standen P. et al. (2014) *Engaging Students with Profound and Multiple Disabilities Using Humanoid Robots.* In: Stephanidis C., Antona M. (eds) Universal Access in Human-Computer Interaction. Springer International Publishing 419-430.

[7] Salt, T.(2010) *Salt Review: Independent Review of Teacher Supply for Pupils with Severe, Profound and Multiple Learning Difficulties (SLD and PMLD),* http://www.thedyslexia-spldtrust.org.uk/media/downloads/inline/the-salt-review.1298547606.pdf

[8] M. Walker and A. Armfield, (1978) *The makaton vocabulary*, in *Ways and Means*, Globe Education, Basingstoke, pp. 174-184.

[9] Diginext (ed.), D2.4 Full System Architecture. Deliverable of the MATHISIS project, 2017

[10]Nottingham Trent University (ed.), D2.5 Evaluation Strategy. Deliverable of the MATHISIS project, 2016

[11]CERTH (ed.), D4.2 MaTHiSiS Sensorial Component. Deliverable of the MATHISIS project, 2017

[12] CERTH (ed.) D4.1 MaTHiSiS Sensorial Component. Deliverable of the MATHISIS project, 2016