Managing Affective-learning THrough Intelligent atoms and Smart InteractionS

D.8.1 Report on Autism Spectrum Case pilots

Workpackage	WP8 – Pilots in Education
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List of Acronyms

Abbreviation / acronym	Description
ASC	Autistic Spectrum Case
ASD	Autistic Spectrum Disorder
CGDLC	Career Guidance Distance Learning Case
CLB	Cloud-based Learner's Space
DSS	Decision Support System
EE	Experience Engine
EOPPEP	EOPPEP is the National Organisation for the Certification of Qualifications and Vocational Guidance in Greece
FMD	Fondazione Mondo Digitale
HCI	Human Computer Interaction
ID	Intellectual Disability
ICT	Information and Communication Technologies
ITC	Industrial Training Case
IWB	Interactive White Board
JCYL	Consejería de Educación Junta de Castilla y León
KPI	Key Performance Indicator
LCDS	La Cometa del Sud
LA	Learning Action
LAM	Learning Action Materialisation
LG	Learning Graph
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 @UEL	RIX Research and Media at the University of East London
SC	Sensorial Component
SEN	Special Education Needs
SLA	Smart Learning Atom
UEL	Uiniversity of East London
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 information on the outcomes and outputs resulting from the process of preparation and implementation of the first phase of Pilots in Education - Driver Pilots - for the Autism Spectrum Case - ASC.

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

The MaTHiSiS learning vision in the particular ASC is to provide a product-system for education for individuals with an intellectual disability and non-diagnosed ones. It consists of an integrated platform, along with a set of re-usable learning components (educational material, digital educational artefacts etc.), which are composed into learning graphs. These Learning Graphs (LGs), acting as a novel educational structural tool and associated with specific learning goals, have been developed in collaboration with school teachers and aim to foster novel ways to guide how the different Learning Materials (LMs) and artefacts can be deployed throughout a pre-specified learning scenario. The LMs of these graphs have been drawn by pedagogical partners in collaboration with technical partners from a set of Smart Learning Atoms (SLAs), learning elements that carry stand-alone pieces of learning materials, targeting certain needs. The learning goals as well as the SLAs selected for the Driver Pilots have been agreed with school teachers and practitioners directly working with students, based on common teaching and learning practices.

In the driver phase of the ASC 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
  IC Rita Levi Montalcini
  Association FareABA
  I.C. Leonardo da Vinci
  Private School Giacomo Sichirollo
  Il Mosaico – Società Cooperativa Sociale ONLUS
  Il Mosaico – Società Cooperativa Sociale ONLUS
- Spain
  Equipo de Atención a Alumnos con Trastorno de Conducta de Valladolid (Counselling team for students with behavioural disorders)
  CEIP "GONZALO DE BERCEO" - Centro de Educación Infantil y Primaria "Gonzalo de Berceo"

Internally, this deliverable serves as a detailed frame of reference for the evaluation of the MaTHiSiS Driver Pilots and as a starting point for the development of the second phase of the Pilots in Education - Assisted Pilots. For readers external to the project, this deliverable describes the process followed to elicit requirements, details of those requirements and their codification across the use cases the Use Cases, and the process of breaking learning materials down into SLAs and Learning

Action for the MaTHiSiS platform to be piloted in a driver setting by users with a different spectrum learning disabilities. Finally, the document contains references to users' feedback gathered by tutors at the venues, regarding the pedagogical potential of MaTHiSiS in the context of special needs education.

1 Introduction

The objective of this deliverable is to provide an overview of the steps implemented to set up and run the Driver Pilot sessions within Autism Spectrum Case analysing both MaTHiSiS system technical requirements and users requirements in a continuous collaboration between pedagogical partners representing end users point of view and technical partners focusing on the development of a product-system to be used in formal, non-formal and informal education. MaTHiSiS user-centred approach was applied since the very beginning of the of the Driver Pilots deployment plan, involving stakeholders in a continuous process of validation of the Learning Experience adaptation and personalization mechanism dealing with legal and security aspects related to the system architecture.

The document is divided into the following sections:

1. Description of the Autism Spectrum 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 Autism Spectrum Case

2.1 Brief Description

Three different cases, working with students aged 5 to 18 years old:

1) 'Low-functioning' autism without much communicative speech
2) 'High-functioning' autism or Asperger syndrome, and
3) People with autism spectrum conditions at all levels of functioning, with intense sensory perceptual sensitivities, attention deficit in comorbidity with specific learning disabilities, limitations in gross and fine motor control.

Autism (or "classical autism") is a neurodevelopmental disorder characterized by deficiencies in social interactions and communication skills, as well as repetitive and stereotyped patterns of behaviour. Autism is characterised by three distinctive types of behaviour – difficulties with social interaction, problems with verbal and nonverbal communication, and repetitive behaviour or narrow, obsessive interests. Autism Spectrum Disorder (ASD) can be associated with intellectual disability, sensory perceptual dysregulation (conventionally innocuous stimuli can be perceived as intense and aversive), difficulties in gross and fine motor coordination, attention deficit and emotional dysregulation. The impact of these can range from mild (e.g. Asperger syndrome in which communicative language itself is intact or superior but pragmatic social communication remains impaired) to profoundly disabling (total lack of speech, or of communicative use of speech). Autism arises as a spectrum of conditions, of which the most profoundly disabling are labelled as disorders by most people whereas the mildest merge into typical individual variation in cognitive profiles. Most cases of autism, and autism spectrum conditions, are idiosyncratic, having no known single biological cause. A minority of autism cases can arise with known neurobiological disorders such as Fragile X syndrome. Other ASDs include Asperger's syndrome, Landau-Kleffner Syndrome, Childhood disintegrative disorder, and PDD-NOS[1] (pervasive developmental disorder not otherwise specified).

Children with autism are deemed to have special educational needs as they have significantly learning difficulties – and also unconventional learning advantages that are often unexploited – than the majority of children of the same age, or a disability that prevents or hinders them from making use of educational facilities of a kind generally provided for children of the same. A statement of special educational needs means additional resources are delegated to schools to support their inclusion.

2.2 Associated challenges, Goals and Example Scenarios

There are many challenges associated to this user group, linked to difficulties repeating procedures, needs for vocal repetition of instructions or pictures/signals guiding her during the task, difficulties of verbal expression and emotional recognition.

Examples of the main challenges encountered by students with autism include difficulties achieving school demands; revealing behavioural difficulties linked to emotional control; difficulties with executive function such as paying attention and being able to generalize information to wider settings. Students with an ASD behave hyperactivity and emotionally and manifest higher levels of anxiety than their peers. ASD students report difficulties in communication and social engagement, thus the relationship between ASD student and the teacher is fundamental for their successful learning path and the use of technologies should not disrupt this relationship. An inclusive school setting is essential to increase sense of self-worth and esteem that can reduce problematic behaviours. Technologies are perceived on one side as useful to develop cooperative-learning environments; on the other side could pose organisational problems (too much time to be allocated, availability of the devices or of the technical assistance and training, isolation of special needs

[1] https://www.autismspeaks.org/what-autism/pdd-nos

students. Tutors and teachers at the venue reported the topics in which the technology could help them in their work supporting ASD students' learning paths are communication and social interaction, emotional management, enhancement of short attention span, and learning goals that offer the opportunity for sensory integration (Ex. Combining pictures, verbal indications and fine motor action) within the learning path.

The goal of MaTHiSiS pilots is to verify to which extent the ecosystem can support teachers, carers, tutors and learners teaching and learning to develop students' abilities. 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 Pilots Phases

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

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

3.2 Stakeholders Roles

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

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

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

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

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

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

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

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

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

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

In the ASC supervised learners only can be involved.

4 ASC Pilots Preparation Activities

4.1 Stakeholders Selection

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

- Two of the organisations selected to organise the pilot are specialist schools for pupils and students with autism diagnosis. two of them are based in UK, one enrolling students from 3 to 19 years, one from 11 to 16 years.
- Two of the selected organisations are associations providing support and educational services to children with autism diagnoses based in Italy; one enrols children approximately aged 10/12 and the other 3 to 19 years old.
- One organization in Spain is a counselling team (three psychologist and two teachers are working on it) that works with children with behaviour disorders at school, four of them with autism, from low-functioning to High functioning autism.
- The remaining five organisations are mainstream schools that include autism-spectrum students: two Italian public schools, and two schools in Spain.

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 Research and Media, University of East London – RIX@UEL

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 this year's 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 ASC are young people between the ages 11-14. They have Autistic Spectrum diagnosis and some additional learning difficulties.
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, Eye Gaze, 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	The school is keen to participate and have been extremely accommodating.

participate	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 Fondazione Mondo Digitale – FMD

Organisation Name	*IC Rita Levi Montalcini*
General Description of the Organisation	Primary and secondary first grade public school (students aged 3 to 14 years) known for the training of teachers linked to new technologies and initiatives related to innovative teaching approaches focusing on collaborative learning, student centred pedagogy, flipped classroom. It counts on a professionally prepared staff, in particular regarding the education of students with special needs. The class of approximately 22 students selected to take part in the pilot enrols students aged 9/10 including 6 ASD. The school is equipped with interactive whiteboard, PC and 6 tablets.
Description of the Characteristics of the Services users at that Organisation	1 student aged 9 with Fragile X Syndrome also affecting motor coordination, demonstrates severe intellectual disabilities revealing in learning disorders and language delay (dyslalia) in comorbidity with attention deficit hyperactivity disorder, social and behavioural and social cue disorders 1 student aged 10 with severe intellectual disability and affections in motor functions in comorbidity with attention deficit hyperactivity disorder, demonstrates learning disorders, language delay and selective mutism, repetitive behavioural and social cue disorder 1 student aged 10 demonstrating severe learning difficulties, communication and social disorders. 1 student aged 9 with motor coordination difficulties and learning disorder ascribed as global delay 1 student aged 10 with attention deficit and learning disorders (reading/writing) 1 student aged 10 with learning difficulties in maths, reading and writing.
Support Mechanisms for the use cases	The pilot will be organised at the school venue providing teachers the required technical support and training. 3 teachers, one in-service, and 3 support teacher will be involved, all have experience using ICT for teaching and learning. The class is equipped with IWB, PC and 6 tablets, available for use in the pilot stages.
Motivation to participate	Enhance teachers' skills using ICT for teaching; enhance the development of student pedagogical approach, developing personalised learning experiences and inclusive learning environment.

Table 5 – Stakeholder information: I.C. Rita Levi Montalcini

Organisation Name	*Association FareABA*
General Description of the Organisation	FareABA is an association of psychologists that deals with Autism and Pervasive Developmental Disorders. It cooperates with schools and families, providing assistance to children with special educational needs. The staff is

	specialized in psychology, Clinical Childhood, Adolescence and Family Psychology.
Description of the Characteristics of the Services users at that Organisation	1 high functioning autistic pupil aged 11 demonstrating learning disorders, social cue disorder and behavioural rigidity global delay, language difficulties such as prosody. 1 low functioning autistic pupil aged 12 demonstrating learning disabilities, difficulties in auditory processing sensory integration, moderate intellectual disorder, behavioural disorders such as stereotypies, social cue, language delay and phono articulation difficulties.
Support Mechanisms for the use cases	The pilot will be organised at the association venue providing training and technical assistance. Two psychologists will be involved, specialized in Clinical Childhood, Adolescence and Family Psychology. Both have experience in using mobile technologies for psychotherapy and behavioural interventions.
Motivation to participate	Integrate into the assistance to children with special educational needs the use of tools for affect state recognition.

Table 6 – Stakeholder information: Association FareABA

4.1.2.2 Polo Europeo della Conoscenza – PE

Organisation Name	*I.C. Leonardo da Vinci*
General Description of the Organisation	Istituto Comprensivo Leonardo da Vinci includes about 2000 students from 3 to 14 years old. It is a public school network consisting of 9 different schools (5 preschools, 3 primary schools, 1 middle school) in a high plain and hilly area around Verona. The network can be further broken down into: 5 'Early Years' schools with students from 3 – to 5 years old 3 Primary schools with students aged 5 – 10 years old 1 Middle schools with students aged 10 – 14 years old
Description of the Characteristics of the Services users at that Organisation	There are about 69 students with a Learning Disability (3-14 years old) at various levels (Cerebral Palsy, Down Syndrome, Autistic Spectrum), and about 30 special need teachers to support them. All will participate in the project as part of their 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 7 – Stakeholder information: Istituto Comprensivo Leonardo da Vinci

Organisation Name	*Private School Giacomo Sichirollo*
General Description of the Organisation	The school G. Sichirollo is a private school that includes 316 students from 3 to 14 years old. The school is part of the network of schools "senza zaino (without schoolbag)" and the teachers working within the school are all highly qualified and in continuous training. The main feature of the school is to deal professionally with the growth of children and young people, caring beyond the educational-educational aspect, even the human one.
Description of the Characteristics of the Services users at that Organisation	There are 4 learners with a Learning Disability at various levels (Cerebral Palsy, Down Syndrome, Autistic Spectrum), and 4 special need teachers to support them.
Support Mechanisms for the use cases	Teachers and special needs teachers know the use of computers with Microsoft. A range of tablets, the IWB and a robot NAO were also available for the use in the project.
Motivation to participate	Private School G. Sichirollo participated to the driver pilot phase of MaTHiSiS project to improve the ICT competences of the special need teachers and to provide – in future – new teaching tools.

Table 8 – Stakeholder information: Scuola Paritaria G. Sichirollo

Organisation Name	*Il Mosaico – Società Cooperativa Sociale ONLUS*
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. One student reports autism spectrum disorder.
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 9 – Stakeholder information: Social Cooperative Il Mosaico

4.1.2.3 La Cometa del Sud – LCS

Organisation Name	*Primary School "I circolo didattico" Cava dei Tirreni"*
General Description of the Organisation	Primary public school (students from 6 to 10 years based in Cava dei Tirreni (Salerno). The school is a primary public school (students aged from 6 to 10 years old based in Cava dei Tirreni (Salerno). Since 2013, the "I Circolo Didattico" has three different locations in different areas of the city but the pilots took place in the main one in the city centre named "Don Bosco" in Corso Mazzini, n.10. The school has two canteens for the kids and for the afternoon classes, a fully equipped, a modern gym, 25 classrooms with a IWB, a children friendly library, a multi-media library, some labs: informatics, linguistic (IWB), multi-media (IWB), science (IWB), music (IWB), history - geography and art (IWB).
Description of the Characteristics of the Services users at that Organisation	At the beginning of June there are involved 4 students, 2 with a fragile X Syndrome aged 6 and 2 with dysregulation in attention and Hyperactivity disorder aged 8.
Support Mechanisms for the use cases	Two teachers are involved (both support specialist for special needs). Two LCS tutor are also present during the pilot realized by using a tablet and a smartphone in a dedicated setting, which is the Hi-tech lab of the school.
Motivation to participate	The school is a looking forward school with an open approach to introduce innovations, which can be attractive for the students of the area and, due to this characteristic, they already have many students with special needs.

Table 10 - Stakeholder information: Primary School I Circolo didattico di Cava dei Tirreni

4.1.3 Spain

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

Organisation Name	*Equipo de Atención a Alumnos con Trastorno de Conducta de Valladolid (Counselling team for students with behavioural disorders)*
General Description of the Organisation	The counselling team for students with behavioural disorders is composed by teachers that hold the especially of Psychology and Pedagogy. They have a classroom where two teachers work with most difficult cases. Many of these most difficult cases are pupils with ASD. Psychologist, pedagogist and teachers have received training on the educative use of PC and tablets. Pupils are allowed to bring their own tablets.

Description of the Characteristics of the Services users at that Organisation	Children with high and middle/low functioning autism aged from 6-11 years old
Support Mechanisms for the use cases	Computers and tablets that can be used for the project. One NAO robot are available for use (provided by JCYL for sharing in all the cases). 3 psychologists are involved, 2 of them with high experience on working with families as well. There will also be involved 2 support teachers
Motivation to participate	This institution is collaborating with the project on piloting because they are happy to explore new tools that can help on the children global development

Table 11 – Stakeholder information: Equipo de Atención a Alumnado con Trastornos de Conducta

Organisation Name	*CEIP "GONZALO DE BERCEO" - Centro de Educación Infantil y Primaria "Gonzalo de Berceo"*
General Description of the Organisation	This is an infant and primary school. ✓ There are around three hundred pupils, with ages ranging from 3 to 12 years old. ✓ School teachers have received training on IWB and mobile devices for educative use, management of ICT resources.
Description of the Characteristics of the Services users at that Organisation	Students' ages range from 3-12 years, and are in mainstream education. In each class, there will be at least 2 students with 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 on the driver pilot phase due to their interest on using ICT new tools that can improve learning process by introducing passive sensors that detects emotional states and personalization of the learning path considering individual characteristics on ASC.

Table 12 – 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 Full scenario of all use cases"[2] from semi-structured interviews with domain experts (teachers, trainers & pedagogists) for each of the Use Cases, technical partners compiled the initial set of User Stories for MaTHiSiS and defined the core functionality of the platform and its components, presented in "D2.4 Full System Architecture" [3].

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 MaTHiSiS sensorial component M18 [4].

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.

4.4 Development of Smart Learning Atoms

Each pilot partner was involved in the development of Smart Learning Atoms for their pilots. **The 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**. In other words SLA is a small learning goals. The development of the SLAs was informed by previously collected user requirements and individual user profiles.

4.4.1 UK

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

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 ASC and 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. The learning progress is monitored and recorded, the level of support required and prompting is also taken into consideration.

4.4.2 Italy

4.4.2.1 Fondazione Mondo Digitale - FMD

FMD delivered their Driver Pilots at IC Rita Levi Montalcini and Association Fare ABA. The students involved have been diagnosed with ASC and complex additional learning needs. In service teachers and support teachers, as well as parents were involved identifying specific Learning Goals for each pupil personalised learning path, considering their individual needs and disabilities, the social and learning environment. These SLAs were discussed and validated with all teachers and tutors involved in the Pilots in order to make sure that they were in line with the learning path of their students enrolled in the mainstream classes.

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

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

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

4.4.2.2 Polo Europeo de lla Conoscenza - PE

PE delivered the Driver Pilot in three 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 private school "G. Sichirollo" of Rovigo the SLAs involved attention, language, maths and social skills:

- Visual/hearing attention
- Synonyms / antonyms
- Semantic fields establishment (conceptual networks)
- Number Quantity correspondence
- Discrimination of greater than /less than
- Emotional awareness
- Eye contact

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

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

4.4.2.3 La Cometa del Sud - LCS

LCS was only marginally involved in this phase and used the SLAs created by FMD and checked them with the teachers and the didactic director of the school to verify they were useful for their students. None specific change was suggested by the local teachers about the SLAs and the LGs proposed by FMD.

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 Equipo de Atención a Alumnado con trastornos de Conducta de Valladolid. Students involved have been diagnosed with Autism Spectrum Disorder, four of them have added behaviour disorders. Teachers found that MaTHiSiS could be useful to improve children emotional skills. The aim of this driver pilot was to check how the platform individualizes student's paths of learning depending on their different characteristics needs. 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 the children has been also taken into consideration.

4.5 Setting of the venue

4.5.1 UK

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

ASC Driver Pilots run 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 are familiar with the use of various interactive technologies, but their access to the Internet is 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, and, due to the issues with the early version of MaTHiSiS, 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

ASC Driver 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 are taking place in a small IT suite that is equipped with an interactive whiteboard, 9 online desktop computers; tablets can also be used in this space. Charlton Park Academy pilots require 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 it was foreseen that each session will last between 15 - 30 min. As the system is not yet very mature and unpredictable, the duration of each session is between 10-20 min per student. A table with laptop and tablet is set-up in one of the corners of the room. A whiteboard is connected to the laptop and available for pilot participants to access the learning experience.

4.5.2 Italy

4.5.2.1 Fondazione Mondo Digitale - FMD

FMD implemented the Driver Pilots in 2 different venues: I.C. Rita Levi Montalcini based in Rome and the Association Fare ABA also based in Rome, in order to experiment the use of the platform in both the context of a mainstream educational environment and assistive learning environment working on pupils' applied behavior analysis. Both the school and the association had previous experiences using ICT for teaching and learning and had a particular interest to cooperate in experimenting new pedagogical approaches for special needs education. FMD equipped the venues based on MaTHiSiS requirement including kinect, tablets, smartphones, wide screen and laptops, ensuring that the organisation of the setting could ensure a proper friendly environment for the students. The duration of the sessions was about 20 minutes per students accompanied by an explanation of the aims of the experimentation before its start and by a final feedback where students could prompt and be aware of the whole process of MaTHiSiS research feeling protagonists.

4.5.2.2 Polo Europeo della Conoscenza - PE

PE planned to run the Driver Pilots for the ASC use case in three different venues: the I.C. "Leonardo da Vinci" of Bussolengo (Verona), the private school "G. Sichirollo" of Rovigo and the social cooperative "Il Mosaico" of Porto Potenza Picena (Macerata). Each venue was equipped by the partner with laptop, Kinect sensor, webcam, tablets and it was foreseen the use of a NAO robot in Bussolengo and Rovigo. In all the three venues the pilot took in a dedicated room with good internet connection and enough space to let the pupils feel comfortable. The duration of the session was of about 10 minutes for the younger users (from I.C. Da Vinci and Sichirollo) and about 20 minutes for the older one (from Il Mosaico). Longer sessions, breaks and pauses were foreseen due to technical reasons.

4.5.2.3 La Cometa del Sud - LCS

LCS realized the Driver Pilots in a single location at the I.C. I° Circolo didattico in Cava dei Tirreni (Salerno) in a location in the city centre. The school is one of the best ranked in the area and particularly well equipped, compared to the area average. The school has in particular an ICT LAB equipped with twelve PC and several tablets. In this lab LCS settles the additional MaTHiSiS equipment such as a Kinect v2, a tablet, a smartphone and a wide screen. The students work separately and jointly in the lab with sessions of different duration according to the needs and skills

of the students from 10 to 40 minutes and also due to some mis-functioning of the system.

4.5.3 Spain

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

ASC Pilots run by JCYL took place at CEIP "Gonzalo de Berceo" and Equipo de Atención a Alumnado con trastornos de conducta de Valladolid. 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 Equipo de Atención a alumnado con trastornos de conducta de Valladolid, driver pilots took place in their usual classroom with good access to internet and devices following technical requirements. Duration of each session varied depending on the technical performance of the platform and student' concentration levels. In general terms, each session lasted about 40-50 minutes or 60 minutes if the time to setup the PAs is considered.

4.6 Teachers training

4.6.1 UK

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

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 assistants 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, RIX involved four teachers 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 are competent in using technology and are enthusiastic in pioneering and testing the MaTHiSiS system. Since the system is not yet mature enough to be intuitive and easy to use, teachers require full assistance from RIX researchers in using and testing the system.

4.6.2 Italy

4.6.2.1 Fondazione Mondo Digitale - FMD

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

4.6.2.2 Polo Europeo de lla Conoscenza - PE

PE organised a first workshop introducing the use of the Learning Graph in January 2017, once the platform was ready the three teachers and practitioners involved in the pilot were introduced to the

use of the system by the tutors, but they still need help to interact with the system.

4.6.2.3 La Cometa del Sud - LCS

LCS ran the driver pilots during the month of May and June 2017 with three tutor from its staff and a group of nine local teachers (two involved for ASC case). The interaction with the teachers was constant during the pilots as they need support to run them because they do not have any ICT skill and the ICT support from the school was present only occasionally.

4.6.3 Spain

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

At CEIP Gonzalo de Berceo (Spain) there were two teachers involved in the MaTHiSiS driver pilots organised by JCYL**.** In the Equipo de Atención a alumnado con trastornos de conducta there are three psychologists and two teachers involved. Each teacher contributed with the input linked to provide information for filling in the learning profile. As the platform was not stable, it was introduced to teachers' right before driver pilots. All teachers at CEIP "Gonzalo de Berceo" and both psychologists and teachers from Equipo de Atención a Alumnado con trastornos de conducta de Valladolid are competent in using technology for pedagogical purposes and all them were highly enthusiastic in pioneering and testing the MaTHiSiS system. The system was not yet intuitive nor easy to use, teachers required full assistance from technical partners (in this case ATOS gave onsite technical support) to use and test the system.

5 ASC Driver Pilot Execution

5.1 Introduction

Driver Pilots were mostly organized at the venue of the school or organization selected. Each piloting partner agreed with teachers and practitioners at the venue about the setting organisation in order to conciliate technical requirements and the necessity to guarantee users comfort and familiarity with the environment, not affecting pilots' outcomes and comply with ethical requirements. The system ensured data protection and parents, teachers and students were informed of the data collection a priori gathering informed assent.

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

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

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

Students also were provided with an overview of the project highlighting their active contribution towards its objectives participating in the pilots. This approach motivated students, who were constantly collaborative during the pilots' execution and aware of the technical issues entailed in a research project. Approximately forty students, aged 6 to 12, interacted with MaTHiSiS platform, engaged in 1 up to 5 sessions each of 10 to 40 minutes.

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, hyperactivity and attention deficit.

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 the Nottingham Trent University - NTU

UoN and NTU carried out the Driver Pilots at Oak Field School in Nottingham. In total four students aged 10 to 14 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 each pupil was asked about their experience and some of them were able to give feedback.

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 ages 11-14. The venue was equipped with the required MaTHiSiS instruments (Laptop, Kinect, 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. The students 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. The students were supported in a number of ways. For example, holding the tablet close to the student's face, taking their fingers and touching the pictures on the tablet 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 Fondazione Mondo Digitale - FMD

FMD organised the Driver Pilots in two different venues, one Association providing support to autistic pupils and one public school enrolling special needs students within the mainstream classes. Eight students were involved aged 8 to 12. The venues were equipped based on MaTHiSiS requirements and the environment was prepared in order to be comfortable for the pupils. The project and objective of the Driver Pilots were introduced to students highlighting their active role in the experimentation and its aim. Information regarding the concrete activities part of the pilot were also provided. Pupils were enthusiastic to participate. FMD tutors assisted the pilot for its entire duration, dealing with teachers in the relationship with the student during the sessions' implementation. Each student was involved in two sessions of approximately 20 minutes each including a final exchange of feedback between the pupil and the tutor. Each pupil was also invited to share his/her thoughts with the other mainstream and special needs students taking part in the pilots. Interested parents also assisted the sessions in some of the cases.

5.1.2.2 Polo Europeo de lla Conoscenza - PE

PE organised the Driver Pilots in three different venues: a private centre offering specialist support to disabled children and two schools (one public and one private) enrolling special needs students within the mainstream classes. A total of four learners (two girls and two boys) with ASD were involved in the project: three of them attend the first year of primary school (6-7 years old) the fourth is 12 years old. The teachers and practitioners were involved in the project since January with a first introduction to the project and the functionality of the MaTHiSiS system. They built the learning graph for their pupils considering their educational needs and the inclusion within the mainstream class: for this reason in one case the LG was the same as the rest of the class, in the others the emotional awareness was the most important goal. The venues were equipped with the required materials and Platform Agents (laptop, webcam, Kinect sensor, tablets and NAO robot) and a dedicated room was prepared in order to let the tutors form PE check the possible technical issues without interfere with the lessons in the classroom.

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

5.1.2.3 La Cometa del Sud - LCS

LCS organised the pilots in a single didactic place, an elementary school located at the centre of the Cava De' Tirreni. It counts more than 1,000 pupils. The children involved are between the ages of 6 and 10. The school inside is well-equipped, has a computer lab that we chose as the setting to develop the pilots. LCS ran the pilots during school time, bringing a couple of children at once belonging to the same class into the lab at different times in the morning. The project and the objective were presented from the very beginning to teachers and student wagers emphasizing their active role in the experimentation and its main purpose. LCS tutors assisted the pilots all along their duration by constantly comparing with the students' reference teachers and collaborating with them helping the relationship with the students during all the operation of the same pilots Each student was involved in two sections that ranged from 10 to 40 minutes depending on the attention shown by the student himself. There was also one case of a student who played the pilots for more than 40 minutes.

5.1.3 Spain

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

JCYL organised the driver Pilots in two different venues, both from the public educational network: an specialised team that works with children with behaviour disorders and an infant and primary school with ASD pupils included in a mainstream classroom. Children with autism from the specialized team and one learner with high functioning autism from the school participated in the driver pilots. Teachers and a psychologist were involved in the project since March 2016, when JCYL interviewed and worked with them in order to create different Learning Graphs adapted to the learners. Both venues had computers, in the case of the school they had also IWB and tablets. A NAO robot, Kinet cameras and some tablets were provided when the venue did not meet the requirements requested by project technicians. Driver pilots were held in two different sessions during 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 13 - Stakeholders involved: Oak Field School

University of Nottingham – UoN	
Number of tutors involved	1
Number of teachers involved	1
Number of students involved	3

Table 14 – Stakeholders involved: Nethergate School

Research and Media – RIX@ UEL	
Number of tutors involved	2
Number of teachers involved	1
Number of students involved	8

Table 15 – Stakeholders involved: Charlton Park Academy

5.2.2 Italy

Fondazione Mondo Digitale – FMD	
Number of tutors involved	3
Number of teachers involved	4 + 3 psychologists
Number of students involved	8

Table 16 – Stakeholders involved: I.C. Rita Levi Montalcini; Association Fare ABA

Polo Europeo della Conoscenza – PE	
Number of tutors involved	2
Number of teachers involved	3
Number of students involved	4

Table 17 – Stakeholders involved: I.C. Leonardo Da Vinci; Private School G. Sichirollo; Social Cooperative Il Mosaico

La Cometa del Sud – LCS	
Number of tutors involved	3
Number of teachers involved	2
Number of students involved	4

Table 18 – Stakeholders involved: Primary School I Circolo Didattico Cava dei Tirreni

5.2.3 Spain

Consejería de Educación – Junta de Castilla y León - JCYL	
Number of tutors involved	3
Number of teachers involved	3 + 3 psychologists
Number of students involved	5

Table 19 – Stakeholders involved: Equipo de Atención a Alumnos con Trastornos de Conducta de Valladolid and 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 per student	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)	4 learners 10-14 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 20 – Users Characteristics, Physical, Social, Learning Environment: Oak Field School and Sports College

5.3.1.2 University of East London - UEL

Organisation Name	*Charlton Park Academy*
Duration of the sessions	10- 20 min sessions per student
Number of sessions per student	4
Description of physical environment	Sessions took place in an IT lab suite - IT lab - one desktop computer setup and connected to an interactive whiteboard. Access to a tablet.
Description of social environment	1 technical assistant, 2 university researchers, 1 teacher and 1 student at a time.
Description of learning environment	Sessions were set up in the IT suite. The research team, technical assistant, the teacher and the student were the only people in the room. The room had lots of natural light and was quiet. The table with the equipment was set up in the middle of the room with plenty of space around it. Teacher and the student were working together on the 1:1 basis; Each student was engaged in the learning activity. Teacher's role was to provide support to each student when required. Technical assistant and the researchers were observing from a distance, giving the student and the teacher space to work together.

Teachers involved (number and subjects)	1 - SEN teacher
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	8 learners, 11 - 14 year olds, ASC with severe intellectual disabilities complex communication needs, difficulties with social interactions and understanding expectations. All students require stimulation to capture and sustain attention.

Table 21 – Users Characteristics, Physical, Social, Learning Environment: Charlton Park Academy

5.3.2 Italy

5.3.2.1 Fondazione Mondo Digitale – FMD

Organisation Name	*I.C. Rita Levi Montalcini*
Duration of the sessions	15/20 minutes
Number of sessions per student	2
Description of physical environment	Class regularly used by the students equipped with Kinect, web camera, laptop, tablet, smartphone, IWB.
Description of social environment	1 technical assistant, 1 tutor, 1 teacher, 1 student for each session The teachers received tutor's training and assistance, but highlighted the need for more time before rehearsal and practice sessions in order to be able to use the system in an educational context. They required a system sufficiently mature to be used in a cooperative learning environment, implying that one and the same Platform Agent (PA) should be usable at the same time by different users. The system ensured data protection and parents, teachers and students were informed of the data collection a priori gathering informed assent.
Description of learning environment	At the I.C. Rita Levi Montalcini was the daily learning environment where the MaTHiSiS setting was organised for students to access one by one at the presence of the teacher and tutor. The students were part of the mainstream class participating in MEC. The environment was comfortable for the students but noisy as for the frequent movement of the students in the outside courtyard. Frequent breakdown of sequential tasks and related indications, multisensory or idiosyncratically unisensory approaches were needed in order to maintain students' attention and not enhance their frustration.
Teachers involved (number and subjects)	2 teachers (literacy, math, geography, history); 2 support teachers,
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	The age range of the users was from 9 to 12 years old, all speaking Italian language only. Some of them have mild to severe intellectual disabilities and global delay. Some of them have difficulties in communication and behavioural disorders. All of them have different impairments to take into consideration from a cognitive, perceptual and motor profiles, requiring stimulation to capture, attention to sustain, repetition to predict, positive reinforcements to unsure.

Table 22 – Users Characteristics, Physical, Social, Learning Environment: I.C. Rita Levi Montalcini

Organisation Name	*Association Fare ABA*
Duration of the sessions	15/20 minutes
Number of sessions per student	2
Description of physical environment	Class regularly used by the students equipped with Kinect, web camera, laptop, tablet, smartphone, IWB.
Description of social environment	1 technical assistant, 1 tutor, 1 psychologist, 1 student The psychologists received tutor's training and assistance, but highlighted the need for more time to build their confidence using the system once enough mature to be integrated in the daily activities with students. The system ensured data protection and parents, teachers and students were informed of the data collection a priori gathering informed assent.
Description of learning environment	The environment was comfortable for the students as it was one of the main area where pupils undertake their activities, but noisy as for the frequent movement of the students in the outside courtyard. Frequent breakdown of sequential tasks and related indications, multisensory or idiosyncratically unisensory approaches were needed in order to maintain students' attention and not enhance their frustration.
Teachers involved (number and subjects)	3 psychologists
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	Pupils on the autism spectrum aged 11/12 demonstrating behavioural disorders and learning difficulties.

Table 23 – Users Characteristics, Physical, Social, Learning Environment: Association FareABA

5.3.2.2 Polo Europeo della Conoscenza – PE

Organisation Name	*I.C. Leonardo Da Vinci*
Duration of the sessions	10/15 minutes
Number of sessions per student	1
Description of physical environment	Dedicated room with laptop, NAO robot, Kinect, webcam, tablet, internet connection
Description of social environment	1 teacher, 2 tutors, 1 learner
Description of learning environment	The pupil involved is a 6 years old boy attending the first grade of primary school. Other pupils from the 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)
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	One 6 years old boy with ASD, stereotyped behaviour, sensorial hypersensitivity, restlessness and behavioural problems.

Table 24 – Users Characteristics, Physical, Social, Learning Environment: I.C. L. Da Vinci

Organisation Name	*Private School Giacomo Sichirollo*
Duration of the sessions	15 minutes
Number of sessions per student	1 for each pupil
Description of physical environment	Dedicated room with laptop, NAO robot, Kinect, webcam, tablet, internet connection
Description of social environment	1 special need teacher, 2 tutors, 1 pupil
Description of learning environment	The pupil involved is a 6 years old boy attending the first grade of primary school. Other pupils from the same class are present to the session and play similar activities
Teachers involved (number and subjects)	1 special need teacher
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	- 6 years old girl with pervasive developmental disorder not otherwise specified, stereotyped and repetitive sentences, limited interests, deficit of attention, language delay, occasional disruptive behaviour - 7 years old boy with Autistic Spectrum Disorder, mixed language disorder, difficulties in the social interaction, use of short sentences, getaway behaviour

Table 25 – Users Characteristics, Physical, Social, Learning Environment: G. Sichirollo School

Organisation Name	*Social Cooperative Il Mosaico Onlus*
Duration of the sessions	20 minutes
Number of sessions per student	1
Description of physical environment	Dedicated room with laptop, Kinect, webcam, tablet, internet connection

Description of social environment	1 pedagogist, 1 tutor, 1 pupil
Description of learning environment	The student attend the educational centre 3 times a week to improve her social skills and for specific interventions with the pedagogist
Teachers involved (number and subjects)	1 pedagogist
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	12 years old girl with pervasive developmental disorder not otherwise specified, stereotyped and repetitive sentences, limited interests, getaway and disruptive behaviour

Table 26 – Users Characteristics, Physical, Social, Learning Environment: Social Cooperative Il Mosaico Onlus

5.3.2.3 La Cometa del Sud – LCS

Organisation Name	*Primary School I Circolo Didattico Cava dei Tirreni*
Duration of the sessions	10 minutes each pupil
Number of sessions per student	5 (only 1 pupil played twice)
Description of physical environment	Dedicated room with Hi-tech LAB with laptop, Kinect, webcam, tablet, internet connection
Description of social environment	3 tutors, 2 teachers, 4 students in a friendly and available context of a school which is better than the local average from the organizational point of view
Description of learning environment	The students attend the school every day and has a dedicated support teacher given their special needs but they work and study with the other students in normal classes
Teachers involved (number and subjects	2 specialist support teachers
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	4 students, 2 aged 6 with ASC disorders and 2 aged 8 with Hyperactivity disorder

Table 27 – Users Characteristics, Physical, Social, Learning Environment: Primary School I Circolo Didattico Cava dei Tirreni

5.3.3 Spain

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

Organisation Name	*Equipo de Atención a alumnado con trastornos de Conducta de Valladolid*
Duration of the sessions	40 minutes
Number of sessions per student	1 for each pupil

Description of physical environment	Dedicated classroom with laptop, NAO robot, Kinect, webcam, tablet, internet connection
Description of social environment	2 teachers, 3 psychologist, 2 tutors, 4 pupils
Description of learning environment	All pupils have different important behaviour disorders added to the autism, all of them are in the mainstream schools
Teachers involved (number and subjects)	2 SEN, 3 psychologists,
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	4 pupils: 1- 8 years old - high functioning autism demonstrating behavioural disorders 2- 9 years old - high functioning autism demonstrating behavioural disorders and learning difficulties 1- 11 years old - high functioning autism, selective mutism and demonstrating behavioral disorders and learning difficulties

Table 28 – Users Characteristics, Physical, Social, Learning Environment: Equipo de Atención a alumnos con trastornos de Conducta

Organisation Name	*CEIP "Gonzalo de Berceo"*
Duration of the sessions	20 minutes
Number of sessions per student	1
Description of physical environment	Pupil that participated in the driver pilot is in a mainstream classroom that will be added as a venue for the MEC next pilots
Description of social environment	Dedicated classroom with laptop, NAO robot, Kinect, webcam, tablet, internet connection
Description of learning environment	Pupil with high functioning autism has no learning difficulties.
Teachers involved (number and subjects)	2 SEN teachers
Users characteristics (number, age, peculiar condition, diagnosis or educational needs)	1- 11 years old high functioning autism, non-specific learning difficulties.

Table 29 - Users Characteristics, Physical, Social, Learning Environment: CEIP Gonzalo de Berceo

5.4 Learning goals, Smart Learning Atoms, Learning Materials

5.4.1 Learning goals, 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 30 – Learning graph: Oak Field School and Sports College and Nethergate School

Research and Media - RIX

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 31 – Learning graph: Charlton Park Academy

5.4.1.2 Italy

Fondazione Mondo Digitale – FMD

Learning goals, SLAs and Learning Actions		
Age 9-12		
Learning Goal	**SLA**	**Learning Action**
Enhance Motor Skills	Motor sequencing and spatial coordination	Repeat/imitate a sequence
Enhance Motor Skills	Improve motor coordination (arm and leg coordination, hand-eye coordination)	Hand eye coordination, spatial perception
Cognitive skills	Improve literacy	Compose words/sentences
		Combine picture and word
	Improve language comprehension	Visualise the content
		Make connections
	Improve Maths skills	Number Quantity correspondence
		Discrimination of greater than /less than
		Put numbers in order (ascending/descending)
Communication/Socialisation Skills	Express feelings	Engage in a dialogue
		Recognise emotions
	Social perspective taking	Engage in a dialogue
		Recognise emotions

Table 32 – Learning graph: I.C. Rita Levi Montalcini and Association Fare ABA

Polo Europeo della Conoscenza – PE

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 vocabulary	Synonyms / antonyms	Find synonyms
		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 33 – Learning graph: I.C. Leonardo da Vinci

Learning goals, SLAs and Learning Actions		
Age 7 years old		
Learning Goal	**SLA**	**Learning Action**
Improve attention skills	Visual attention	Look at pictures for a time.
	Hearing attention	Hear and recognize a sound of different words for a time.
Improve vocabulary	Synonyms / antonyms	Find synonyms
		Find antonyms
	Semantic fields establishment (conceptual networks)	Connect words about one semantic field
Improve Maths skills	Number Quantity correspondence	associate a number with a quantity
	Discrimination of greater than /less than	Put numbers in order (ascending/descending)
		Identify the largest / smallest number between two numbers.
Improve social skills	Emotional awareness	Identify emotional facial expressions
		Demonstrate understanding of different emotions

Table 34 – Learning graph: Private School G. Sichirollo

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 35 – Learning graph: Social Cooperative Il Mosaico Onlus

La Cometa del Sud

Learning goals, SLAs and Learning Actions		
Age 6-8 anni		
Learning Goal	**SLA**	**Learning Action**
Improve literacy	Combine picture and word	Combine the image with the corresponding word
Motor sequencing and spatial coordination	Make an image through puzzle	Building a puzzle with growing difficulty increasing the number of tiles
	Repeat/imitate a sequence	Repeat and imitate images that run on the screen
Improve language comprehension	Awareness of the name of the objects represented	Associate the corresponding word with each object
	Awareness of the meaning of words and cognitive abilities	Determine what some objects have in common
Improve math skills	Number- quantity	Associate a number with a quantity
		Put numbers in order ascending or descending

Table 36 - Learning graph: I Circolo Cava dei Tirreni

5.4.1.3 Spain

Consejería de Educación – Junta de Castilla y León - JCYL

Learning goals, SLAs and Learning Actions		
Age 8-11 y.o.		
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 an animated cards
		Make eye contact with different facial expression
	Imitation	Imitate facial expressions

		Imitate body gesture
	Basic emotion recognition	Say emotions
		Classify emotions

Table 37 – Learning graph: Equipo de Atención a alumnos con trastornos de Conducta and CEIP "Gonzalo de Berceo

5.4.2 Learning Materials

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.

Research and Media – RIX

At the Charlton Park Academy driver pilot 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 laptop or tablet 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. By engaging in this step by step process, student should come to recognise that their action will cause an effect.

5.4.2.2 Italy

Fondazione Mondo Digitale – FMD

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

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

Polo Europeo della Conoscenza – PE

At the I.C Leonardo da Vinci Bussolengo the PA used are 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 Private School Giacomo Sichirollo the PA used are 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 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
- 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 is 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 show three different pictures of people and define the emotion they are showing. After that, only one picture is showed and the pupil has to select the correct emotion.

La Cometa del Sud – LCS

At the I Circolo Cava dei Tirreni the PAs used were mainly tablets compliant with the proposed SLAs and LGs. The following LMs were developed to be used during Driver Pilots:

- Combine picture and work_ The tablet provides an image on the screen and the words written below, usually 3, and the child must associate the image with the exact word, for example: image of a dog and in words the word dog.
- Make an image through puzzle_ The child has to build a jigsaw puzzle with four confusing weasels and must be able to put them in the right way to make an imagine. If done it successfully it passes from a jigsaw puzzle of four tiles to a more difficult level by increasing the number of tiles.
- Repeat/imitate a sequence_ LA to 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).

- Awareness of the name of the objects represented_ LA associated with improving literacy: The app displays a picture and the pupil is asked to write the corresponding word.
- Awareness of the meaning of words and cognitive abilities_ The tablet provides two different images between them and underneath them other images, one can find out what the two images above have in common and click on the right image.
- Number- quantity_ LA associates a number with a quantity: The app in the tablet display a number of dots and the pupil has to answer how many they are.
- LA 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 at the "Equipo de atención a alumnado con trastornos de conducta de Valladolid" the PA used were tablets and NAO robot with the following LM:

- Count pictures: the app in the tablet requires to choose among 3 numbers that correspond to the number of pictures on the screen.
- Associate a number with a quantity: The app in the tablet displasy a number of draws and the pupil has to answer how many they are.
- LA Identify emotional facial expressions: The NAO robot asks the pupil to identify and show one emotion (neutral, angry, happy, sad, disgusted, scared). Three levels of difficulty.
- LA identifies a sound that corresponds to an emotion (laugh, crying, etc): The NAO robot cries or laughs and asks pupil which emotion it is.

6 Comments and general remarks

6.1 Teachers perspective

Teachers and psychologists involved in the Driver Pilots' implementation kept a collaborative and participatory attitude during all the sessions. Their expectations are high regarding the positive influence of using MaTHiSiS platform as a support for the personalisation of the learning path, in particular for the inclusion of special needs students. Teachers found useful the Driver Pilots' implementation to understand in practice the platform functionalities and highlighted its potential to enhance student centred pedagogy innovation based on affect state recognition as a further element to evaluate the learning process towards the achievement of a learning goal.

Another positive point raised by researchers and teachers during the Pilot sessions is the opportunity MaTHiSiS offers to integrate the use of new technologies into teaching and learning, integrating digital educational materials besides traditional materials, personalized for each student's special need and learning goal, including sounds and images that can reinforce the learning process of students with learning difficulties.

Several challenges accompanied the accomplishment of such objectives and are related to the development of teachers and students' familiarity with the use of ICT for teaching and learning, the availability and integration of the technical equipment within the organization of the traditional learning environment, and the adequateness of MaTHiSiS learning scenarios and materials to students learning goals and school curriculum. This comes along with the level of maturity of the system to provide valuable learning experiences while students interact with the system

Teachers' comments were generally positive; teachers reacted positively to the structure and were very interested by the future use of MaTHiSiS system. For example, they reported: "The system seema 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 inclusion of sound or music in the activities to aid in keeping students' attention and making pictures larger, especially for those who are visually impaired…reducing the delay between learner's input/answer and the subsequent request of the system can decrease repetitive behaviours in ASDs students during the learning experience"

Despite the specific training given to them, even the teachers more used to the ICT needed a side-by-side support due to the setup 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 and dedicate more time to test the system before the rehearsal with students.

Teachers proposed some changes in the Learning Materials, mainly related to reward mechanism, levels of difficulty and selection of icons/images used, to make them more suitable for this peculiar Use Case.

All positive and negative feedback have been discussed among partners and an action plan is already in place to progress on the further development of MaTHiSiS looking forward for the Assisted Pilot phase.

The following subsections summarize the feedback provided by the teachers in the different countries.

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 a 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 inclusion 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 Fondazione Mondo Digitale - FMD

Teachers and psychologists involved in the Driver Pilots' implementation in Rome kept a collaborative and participatory attitude during all the sessions. They contribute to inform and prepare students, other teachers/psych'ologists and school personnel for the various phases of the Pilots (system and equipment set up, setting preparation, sessions scheduling and implementation), as one of their main objective was the system's integration with the school's environment, curriculum and daily routine.

Due to teachers' low familiarity with ICTs and considering the novelty of MaTHiSiS, system's set up and management required a side-by-side support from the tutor; as the Pilots implementation proceeded, teachers' confidence and familiarity with the system increased.

Teachers and psychologists of both the venues generally approached MaTHiSiS with a solicitous interest, posing questions about its functions and potential. They were aware of the experimental value of the Driver Pilots and provide several feedbacks and opinions during the sessions' implementation that can be summarized as follows:

- MaTHiSiS can be a support for teachers' job with ASDs students, especially in mainstream contexts in which the system can act as a "mediator" between ASDs and mainstream students and between special needs students and teachers;
- MaTHiSiS can potentially provide teachers/psychologists with an additional tool to evaluate students' affect states, particularly of those students with difficulties in social interaction and emotion recognition/expression (ASDs);
- Affect state recognition represents a different approach to teaching, specifically in public schools, introducing the affective sphere as an active element of learning processes;
- Reducing the delay between learner's input/answer and the subsequent request of the system can decrease repetitive behaviours in ASDs students during the learning experience;
- MaTHiSiS fosters the use of ICTs in teaching, seen not only as leisure, but also with a pedagogical value, due to the possibility of programming and defining goals and skills to be achieved.

6.1.2.2 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 the teachers more used to the ICT needed a side by side support due to the set-up of the system and to the different devices involved in the test. One of

their 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 the 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 ASC 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.

6.1.2.3 La Cometa del Sud - LCS

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

They significantly contribute to organize the students for timetables and activities and provide significant support in all phases of driver pilots.

The establishment and management of the system required the tutor to have an initial technical support and to be improved over time because many significant crashes and technical issues raised by using the PAs and 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.

In the case of the pilots with ASD learners that have behavioural disorders, the development of the sessions was completely different than those held with ASC children with no behavioural disorders. In the first case, teachers highlighted that the latency (standby time) between two activities should be shorter as too much time generates frustration and boredom on children and once that happens it is not easy to attract them again, and this affect their learning conditions. Teachers would need that the system gives them the possibility, “the freedom”, of controlling the feedback provided by the devices, in particular, by the NAO robot as sometimes although learners correctly answered the robot said it was not right and caused frustration on children. If the teachers could have some control over feedback it would facilitate their activity. One of the psychologists involved on the driver pilots told “I am not sure these activities are useful for developing emotional skills on the children, but I am sure it is a constant challenge for them to self-control their behaviour”.

As a recommendation, teachers would need to be aware of the next Learning Activity that the Platform Agent is going to start so that they could advance it to the learner. The reason is that ASC needs implies being able of anticipating what is going to happen, especially when the activity or the situation is new for a learner with autism.

6.2 Learners perspective

Generally, students reacted to MaTHiSiS with curiosity and an overall engagement, although the majority of them required a support from the teachers and/or the tutor during the sessions, due to difficulties in handling the devices, difficulties in understanding the system’s requests, severe attention deficit requiring a frequent teacher’s prompt, psychomotor dysregulation affecting posture and fine hand control.

The following subsections summarize the feedback provided by the learners in the different

countries.

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

Some students were unable to indicate whether or not they enjoyed working with the system and playing the games. However, from those who could, there was a general sense that they enjoyed the activities. For example, one student indicated both 'thumbs up' and 'thumbs 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 Fondazione Mondo Digitale – FMD

ASDs students involved in the Driver Pilots in Rome are children and teenagers with a variety of educational needs, related to their specific difficulties and impairments. Generally they reacted to MaTHiSiS with curiosity and an overall engagement, although the majority of them required a support from the teachers and/or the tutor during the sessions, due to difficulties in handling the devices (tablet/smartphone – 2 cases), difficulties in understanding the system's requests (support needed only in a first moment - 4 cases), severe attention deficit requiring a frequent teacher's prompt (2 cases), psychomotor dysregulation affecting posture and fine hand control (2 cases). The support provided to these students is the same they usually need in learning and using devices.

As reported by teachers, and in 2 cases by parents attending the sessions, the use of MaTHiSiS surprisingly increased students' attention maintenance, in particular for 3 low functioning autistic students, that demonstrates an uncommon high collaboration.

It was not possible to have direct comments from all the students involved, however teachers' opinions, simple questions posed to the students after every session and direct observation allow to report some feedbacks from the ASDs students involved:

- ASDs students engaged a direct interaction with the PAs, responding to the system's requests and gradually augmenting their communication with the teacher/tutor, "using" the platform as a mediator;
- LMs should provide more audio and video feedbacks and "rewards" (reinforcement) following the students' achievements;
- Attention maintenance generally increased using the system;

6.2.2.2 Polo Europeo della Conoscenza – PE

The teachers introduced the new setting and devices to the children, for those who worked with the NAO Robot 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.

6.2.2.3 La Cometa del Sud - LCS

ASD children are children aged 6 to 9 and have a variety of educational needs related to specific difficulties and disabilities.

In general, they reacted to MaTHiSiS with curiosity and enthusiasm as they differed greatly from the way they did the lesson, and thus showed a remarkable increase in attention.

Only in one case the child could not complete the session, tend to close it almost immediately because it was attracted by the possibility of opening other sessions of the system.

6.2.3 Spain

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

ASD students involved in the driver pilots in Spain are children with a variety of educational needs: one with selective mutism, one with low functioning autism and the rest are high functioning autism (one of them with behavioural disorders).

Generally, they reacted to MaTHiSiS with fear at the beginning and once they adapted to the situation most of them showed curiosity. They needed support from their teachers to feel comfortable. Most of the ASC children with added behavioural disorders had difficulties to understand PA requests. On the cases of ASC without behavioural disorder, the use of MaTHiSiS increased the student`s attention.

With one exception, the children approached JCYL staff and they asked if they may come back another day and they even kissed the staff (uncommon effective sample towards unknown people).

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 " [5]. 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/ascdriverpilot.

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 phases.

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.

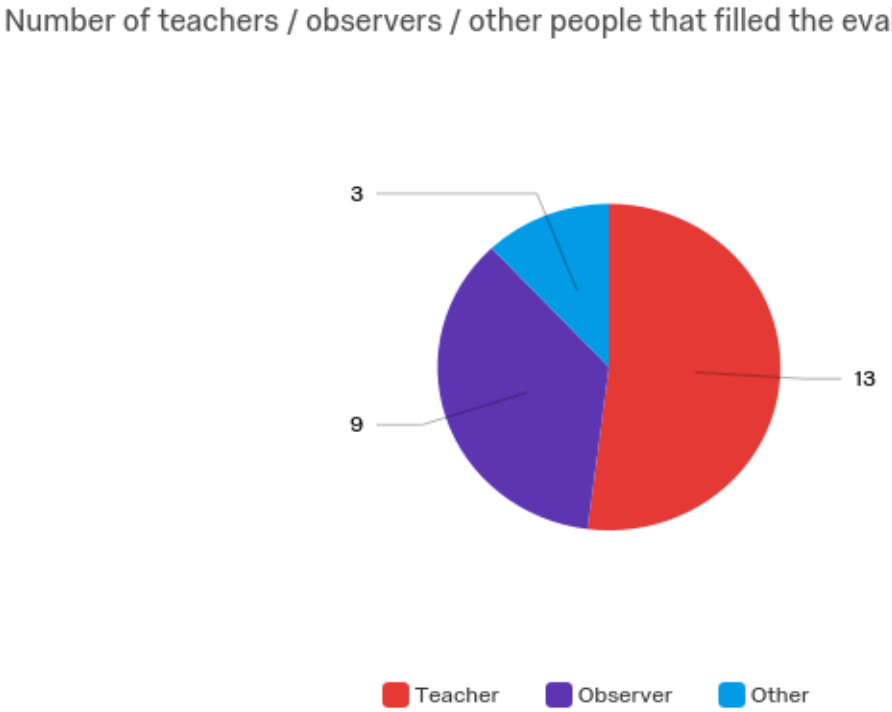

Figure 1 - Stakeholders - Teachers / Tutors / Observers

7.3.2 Learners

The number of respondents to the survey from the student's perspective was 25. All of them but one were teachers or observers that replied on behalf of the learners as in most of the cases they were unable to answer the questions.

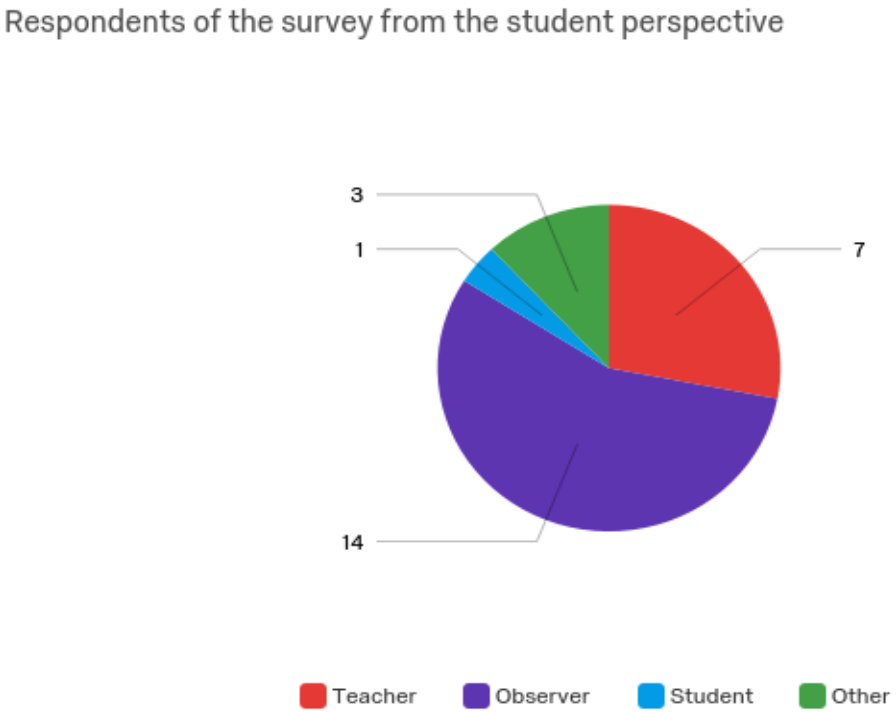

Figure 2 - Stakeholders – Learners

7.4 Results

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

7.4.1 KPI#1 Usability

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

TEACHERS

Questions

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

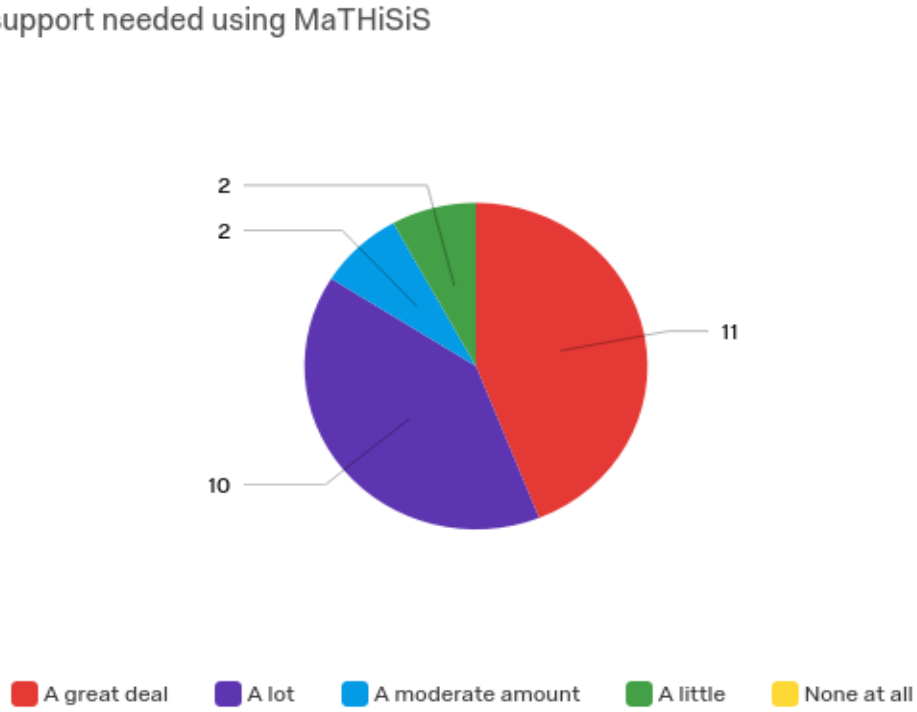

Figure 3 - KPI 1 Usability: Teachers' perspective - Question 1

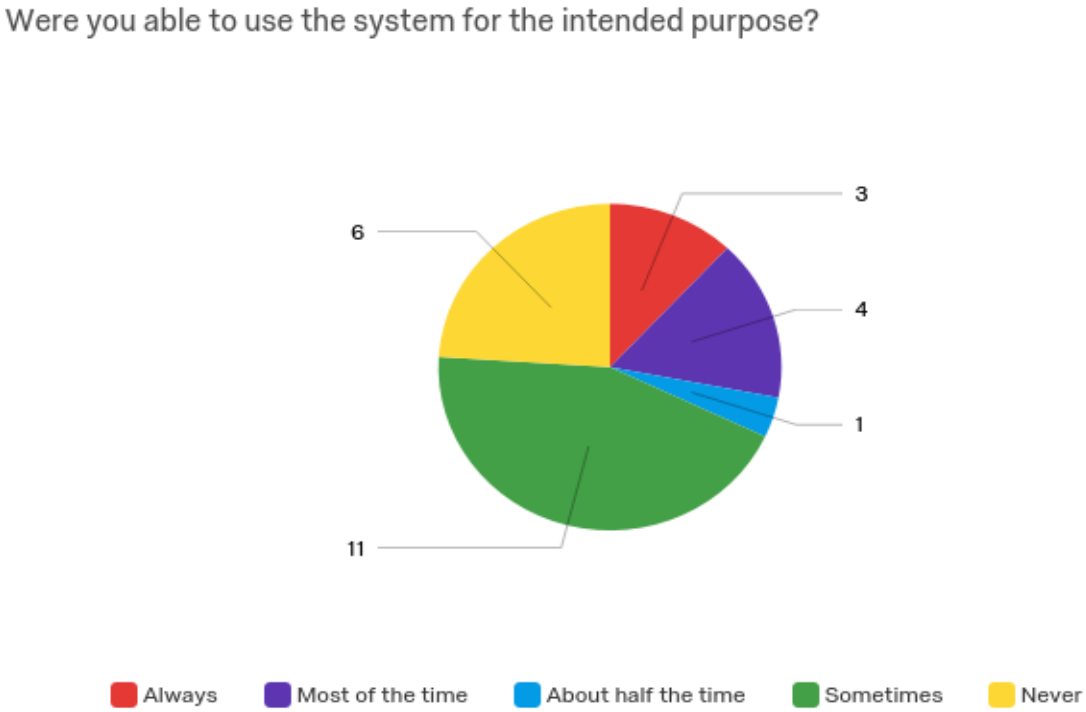

Figure 4 - KPI 1 Usability: Teachers' perspective - Question 2

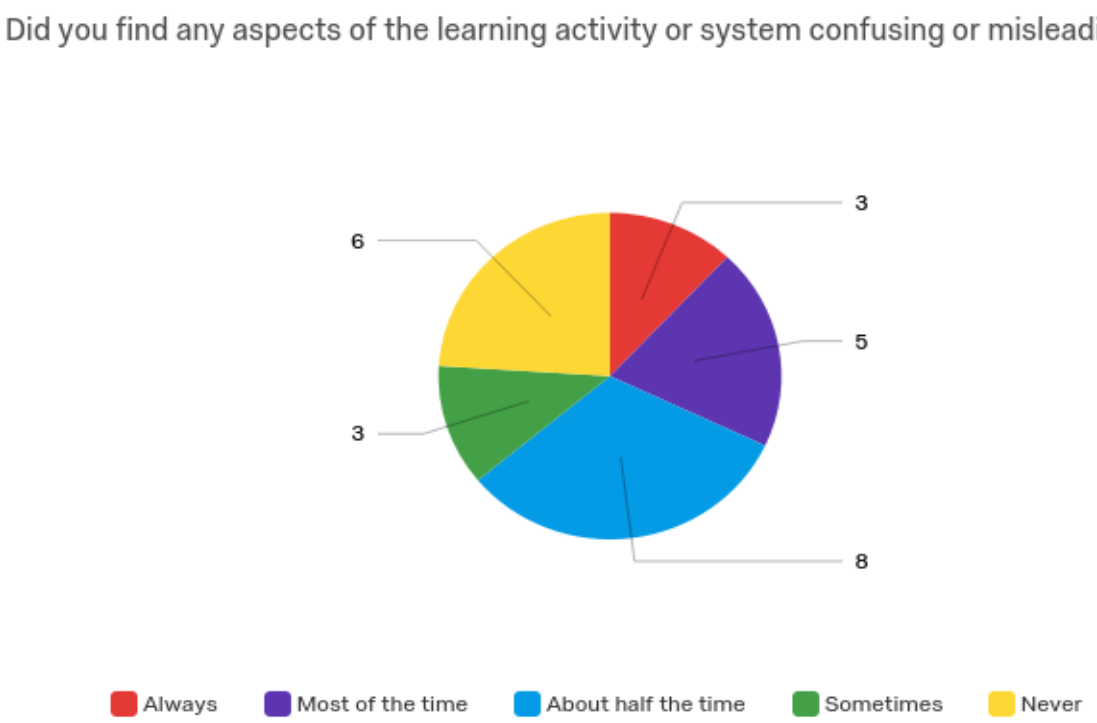

Figure 5 - KPI 1 Usability: Teachers' perspective - Question 3

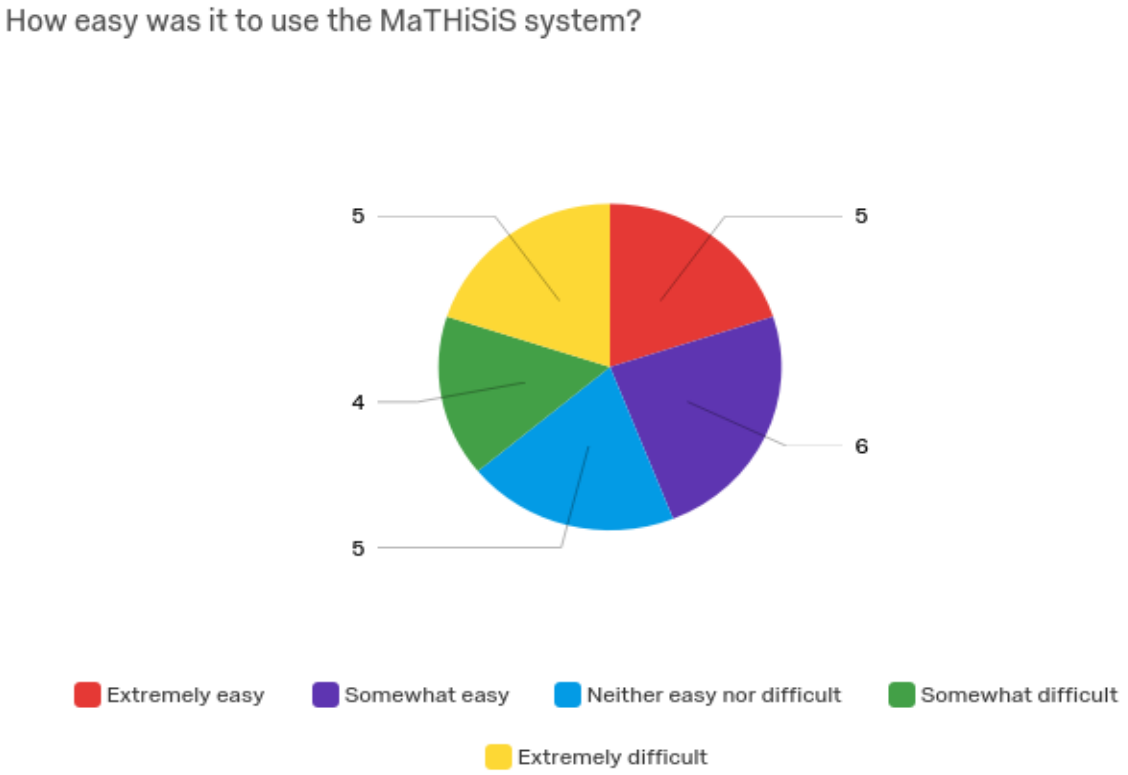

Figure 6 - KPI 1 Usability: Teachers' perspective - Question 4

Conclusions

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

With regards to the question "were you able to use the system for the intended purpose", more than half of the respondents replied that they were not 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", 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.

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.

Was reusing SLAs effective in achieving learning goals?

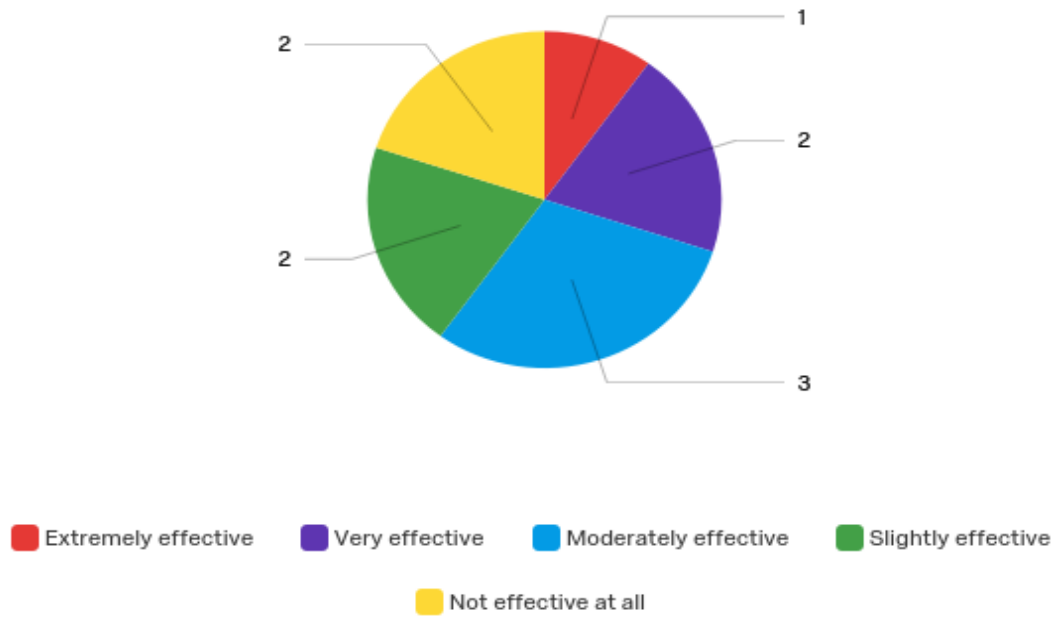

Figure 7 - KPI 1 Usability: Learners' perspective - Question 1

Did you manage to achieve learning goals with previously completed SLAs

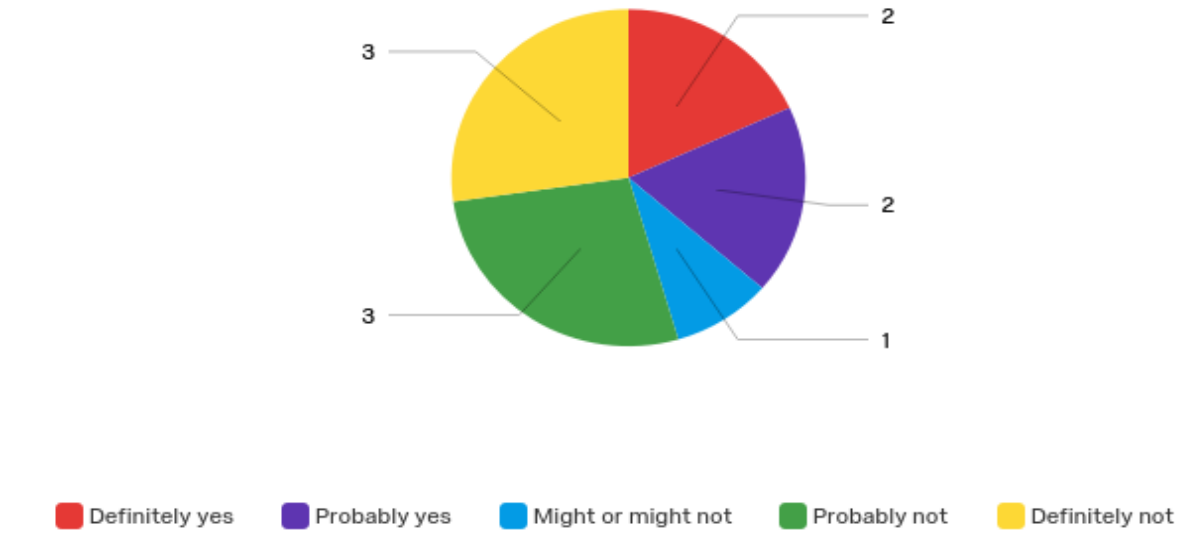

Figure 8 - KPI 1 Usability: Learners' perspective - Question 2

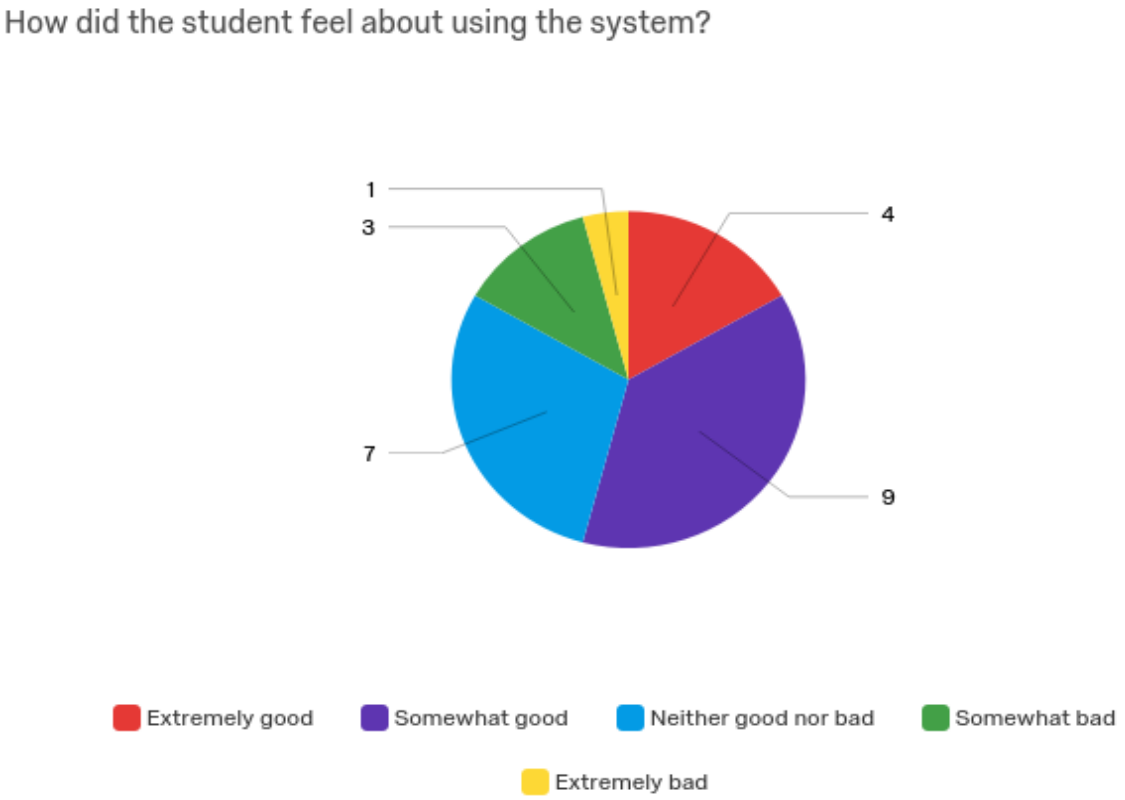

Figure 9 - KPI 1 Usability: Learners' perspective - Question 3

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.

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.

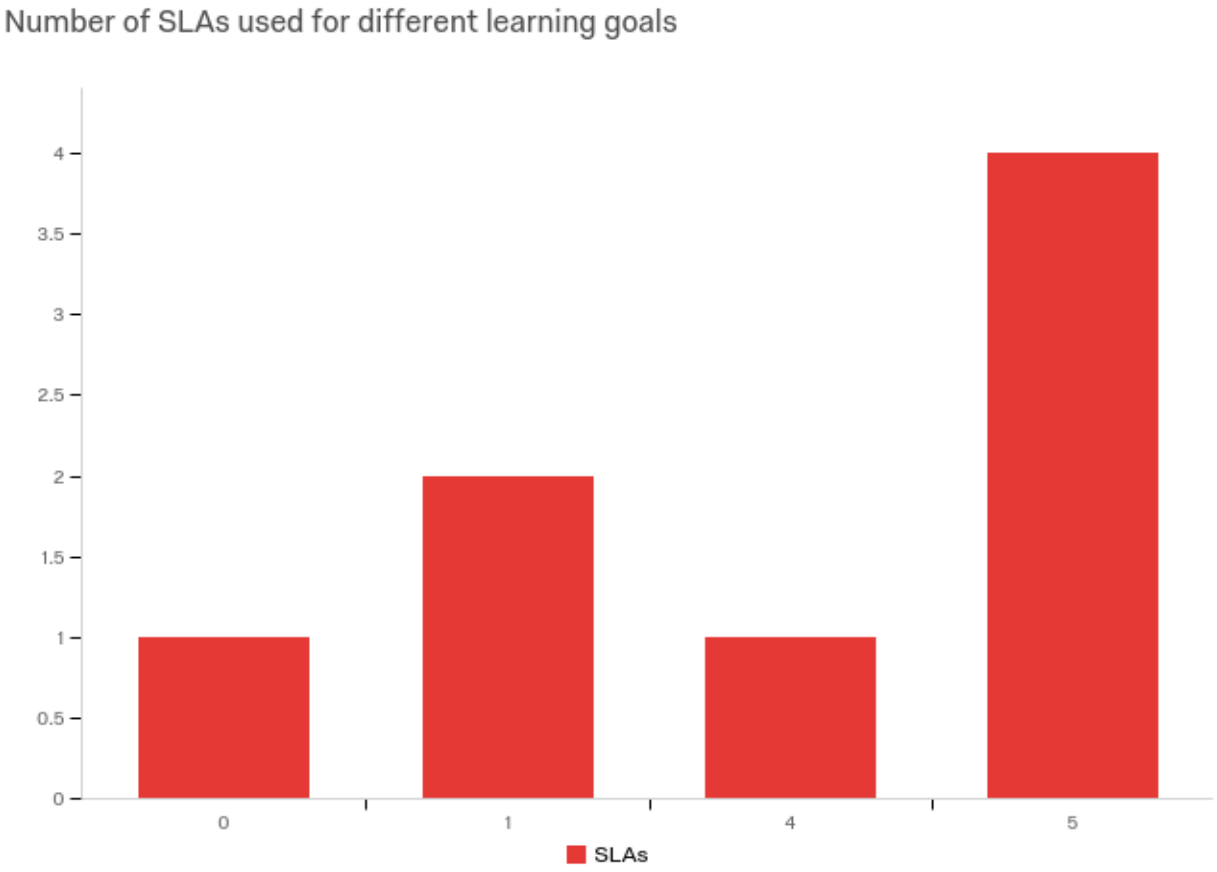

Figure 11 - KPI 2 Reusability: Teachers' perspective - Question 2

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, 4 teachers used 5 SLAs, 1 teachers used 4 SLAs, 2 teachers used 1 SLA and 1 teachers do not use 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.

TEACHERS

Questions

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

Were you satisfied with the non-linearity implementation?

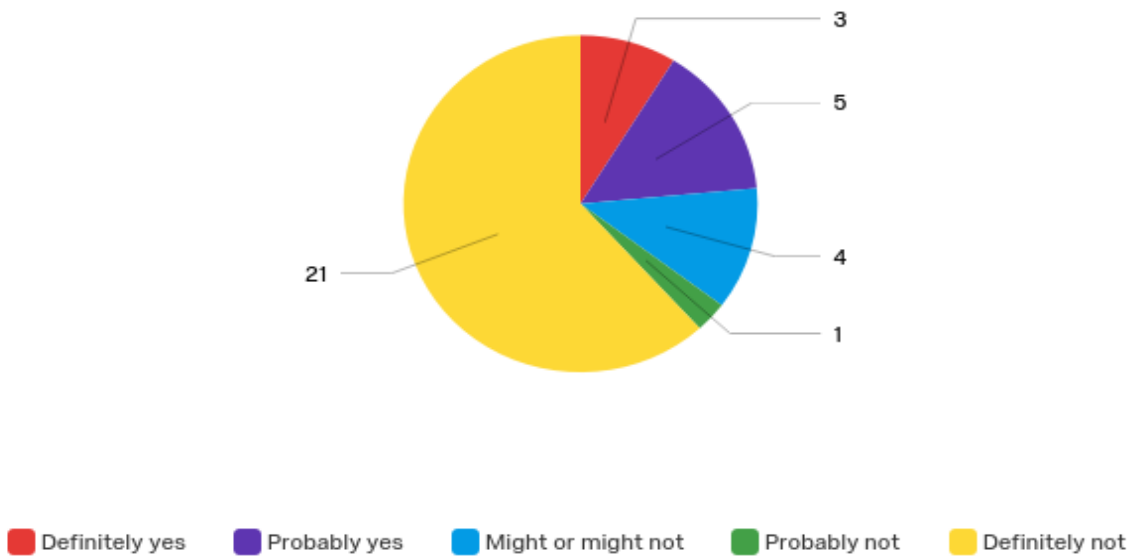

Figure 12 - KPI 3 Non-Linearity: Teachers' perspective

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.

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.

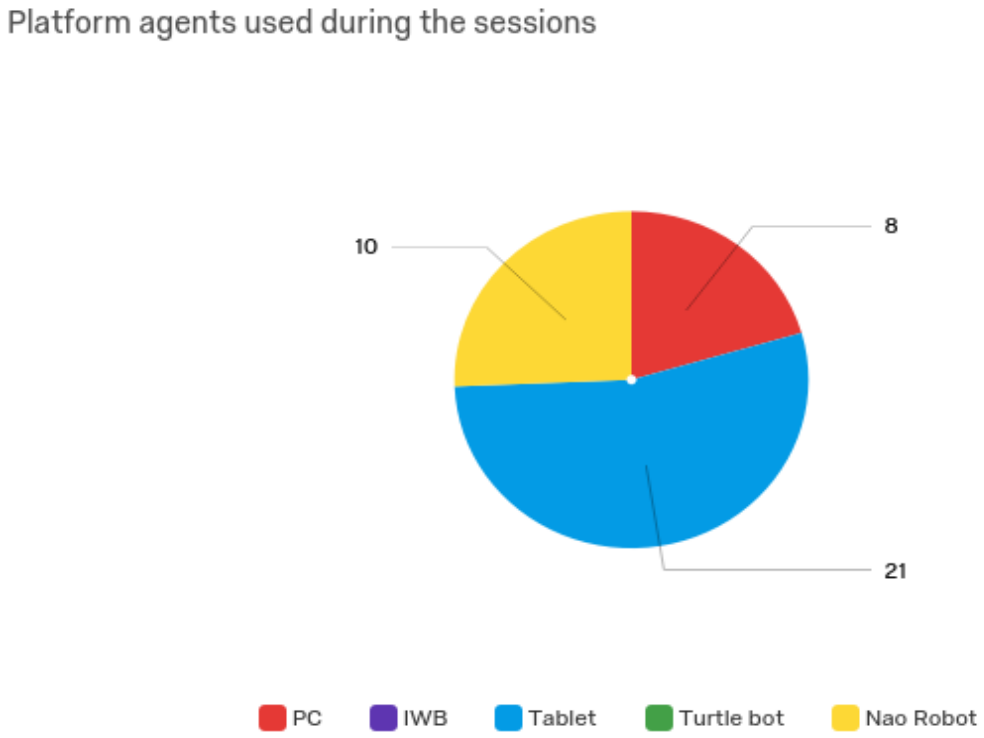

Figure 13 - KPI 4 Accessibility: Teachers' perspective

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 ASC pilots as very few learning materials were available when the sessions were ran. Further materials will be implemented for the assisted pilots. Finally, the learning scenarios using TurtleBots in the driver pilots were not implemented due to the low availability of this device in the schools. An analysis of the possibility of using these agents in the next phase has already been started. The plan is to use these agents in the assisted pilots in specific learning scenarios with the TurtleBots of the consortium members.

LEARNERS

Questions

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

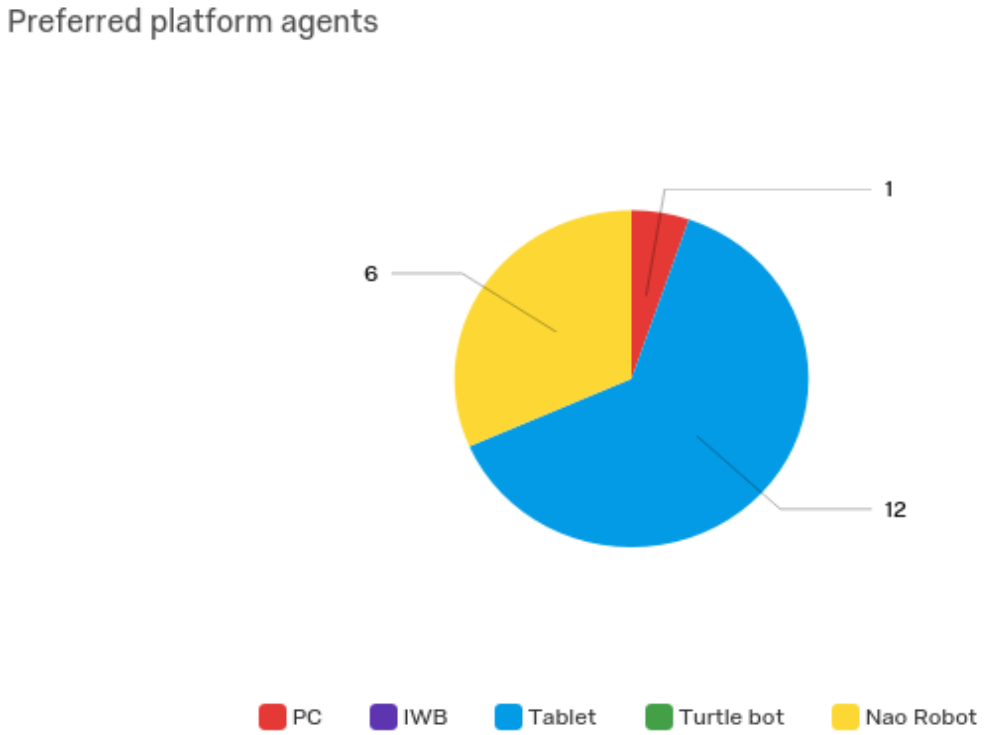

Figure 14 - KPI 4 Accessibility: Learners' perspective

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.

TEACHERS

Questions

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

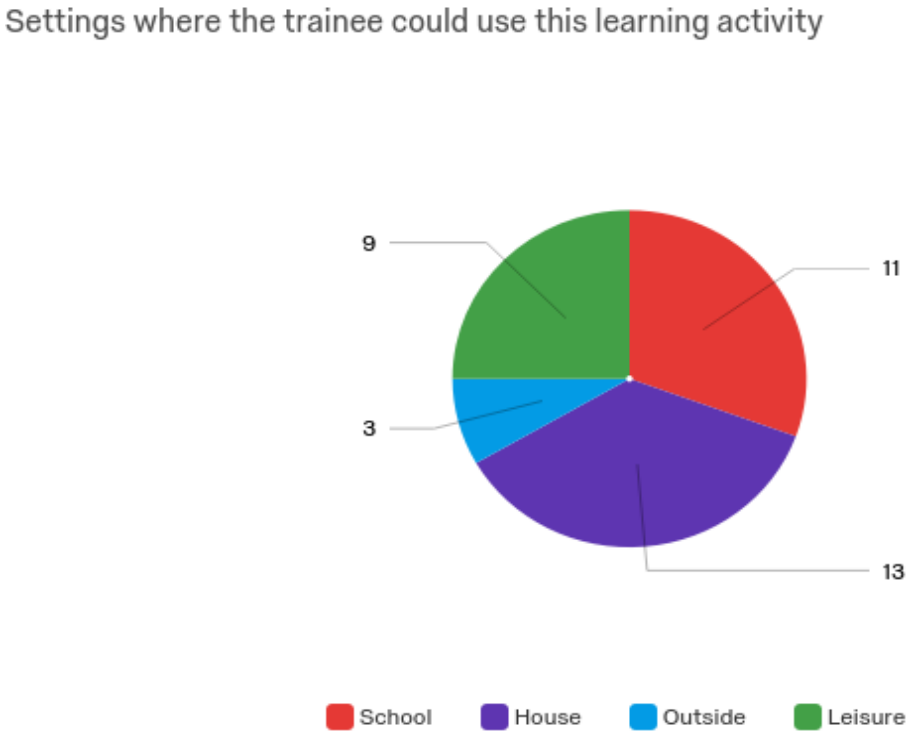

Figure 15 - KPI 5 Ubiquity: Teachers' perspective

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.

TEACHERS

Questions

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

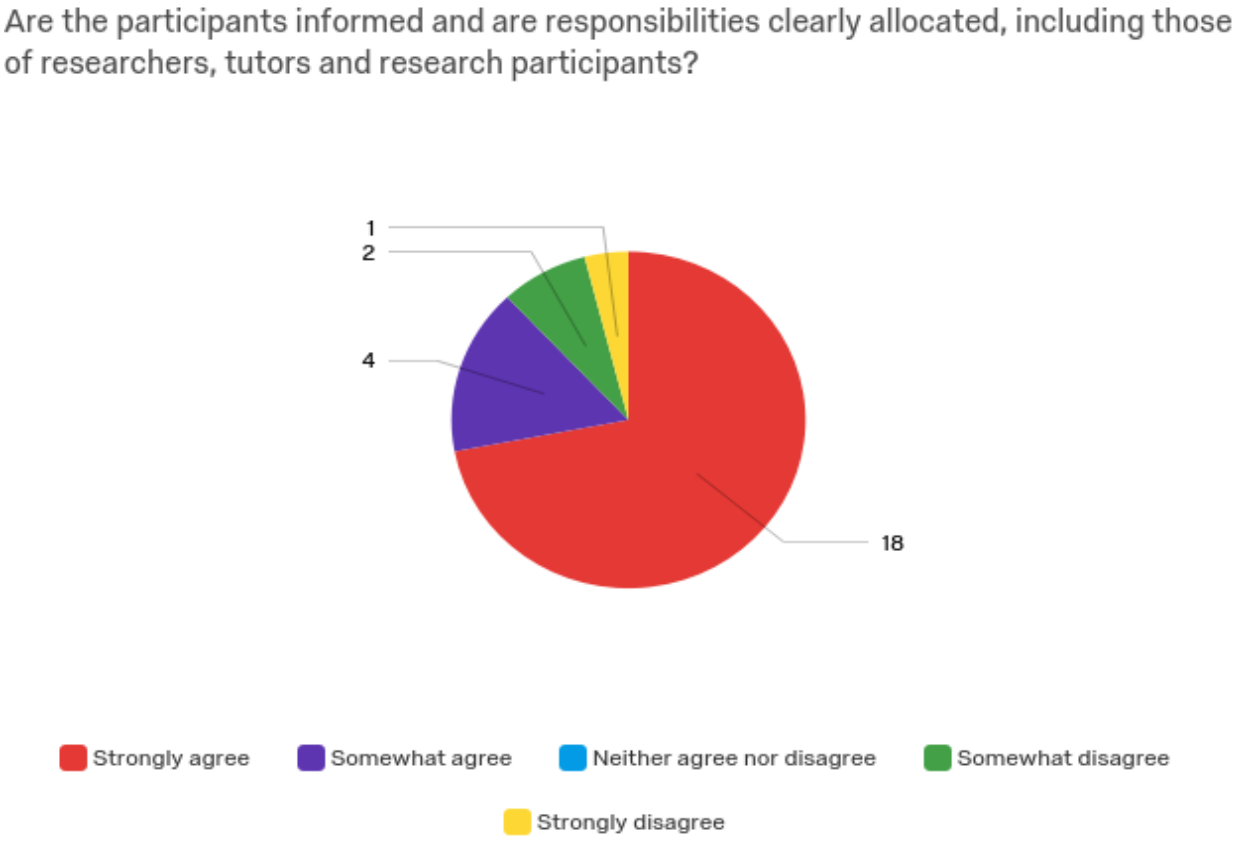

Figure 16 - KPI 6 Ethical adherence: Teachers' perspective

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. The majority of the participants did not have 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 and that the repetition of LMs during a single session can create frustration in the student. The last effects are transient and disappeared when the system propose a new LM. 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

Teachers and psychologists involved in the Driver Pilots' implementation kept a collaborative and participatory attitude during all the sessions. Their expectations are high regarding the positive influence of using MaTHiSiS platform as a support for the personalisation of the learning path, in particular for the inclusion of special needs students. Teachers found useful the Driver Pilots' implementation to understand in practice the platform functionalities and highlighted its potential to enhance student centred pedagogy innovation based on affect state recognition as a further element to evaluate the learning process towards the achievement of a learning goal.

Another positive point raised by researchers and teachers during the Pilot sessions is the opportunity MaTHiSiS offers to integrate the use of new technologies into teaching and learning, integrating digital educational materials besides traditional materials, personalized for each student's special need and learning goal, including sounds and images that can reinforce the learning process of students with learning difficulties.

Several challenges accompanied the accomplishment of such objectives and are related to the development of teachers and students' familiarity with the use of ICT for teaching and learning, the availability and integration of the technical equipment within the organization of the traditional learning environment, and the adequateness of MaTHiSiS learning scenarios and materials to students learning goals and school curriculum. This comes along with the level of maturity of the system to provide valuable learning experiences while students interact with the system

Teachers' comments were generally positive; teachers reacted positively to the structure and were very interested by the future use of MaTHiSiS system. For example, they reported: "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 inclusion of sound or music in the activities to aid in keeping students' attention and making pictures larger, especially for those who are visually impaired…reducing the delay between learner's input/answer and the subsequent request of the system can decrease repetitive behaviours in ASDs students during the learning experience"

Despite the specific training given to them, even the teachers more used to the ICT needed a side-by-side support due to the setup 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 and dedicate more time to test the system before the rehearsal with students.

Generally, students reacted to MaTHiSiS with curiosity and an overall engagement, although the majority of them required a support from the teachers and/or the tutor during the sessions, due to difficulties in handling the devices, difficulties in understanding the system's requests, severe attention deficit requiring a frequent teacher's prompt, psychomotor dysregulation affecting posture and fine hand control.

Teachers proposed some changes in the Learning Materials, mainly related to reward mechanism, levels of difficulty and selection of icons/images used, to make them more suitable for this peculiar Use Case.

All positive and negative feedback have been discussed among partners and an action plan is already in place to progress on the further development of MaTHiSiS looking forward for the Assisted Pilot phase.

9 References

[1] Nottingham Trent University (ed.), D2.1 Formation of the stakeholder group. Deliverable of the MATHISIS project, 2016.
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[4] CERTH (ed.), D4.2 MaTHiSiS Sensorial Component. Deliverable of the MATHISIS project, 2017.
[5] Nottingham Trent University (ed.), D2.5 Evaluation Strategy. Deliverable of the MATHISIS project, 2017.