Students with Learning Disabilities Requirements

Report from stakeholder qualitative survey

EDUROB: Educational Robotics for Students with Learning Disabilities (EDUROB - 543577-LLP-1-2013-1-UK-KA3-KA3MP)

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Contents:

1. Introduction

Students with learning disabilities have developmental delays both at cognitive and social areas which affect their learning and subsequent possible employment potential. The basic starting point is that cognition, a faculty related to perception, imagination, memory as well as problem solving refer to internal mental processes through which sensorial input is acquired, elaborated, used, and stored, affecting in a direct way their learning potential.

Cognitive and social development of students with learning disabilities can be enhanced by means of mediated learning. The concept of mediated learning was signalled by Lev Vygotsky (1978) and R. Feuerstein (2006). Mediated learning is the subtle social interaction between teacher and learner in the enrichment of the student's learning experience. Mediation for learning is an important key to survival and success.

Contemporary research show that robots can be a useful tool in encouraging play interactions which is a key part of encouraging growth in developmental areas. Robots can have a beneficial impact on the learning experience (Standen et. at., 2014). Robots can be more sociable and increase motivation which plays a key role in learning (Saerbeck et al., 2010a, Saerbeck et al., 2010b). Robots can be particularly good at this as they have the potential to be multi-modal and engaging (Robins et al., 2005). Robot encourages play ability in SEN students and imitation through play which fundamental in autistic children (Karna-Lin et al. 2006, Dautenhahm et al. (2002) Robots can be ideal in implementing experiential learning, an approach that can increase the independence of learners in terms of their ability to seek out and assimilate new knowledge.

Based on mentioned above theories of psychological development and due to the fact that humanoid robots represents antropomophic traids (Zawieska, Duffy 2014) project EDUROB proposes an intervention model that aims to drive students' cognitive and social processes while addressing much needed transferable social skills, making use of the possibilities offered by robotics. Robotics are being used to create the channel through which mediated learning strategies can be applied and carried out.

2. Objectives and aims of the survey

The general aim of WP2 was to identify the requirements of students with learning disabilities which should be stimulated. This general aim was split into detailed objectives being investigated during the survey and comparison between counties to find the possible areas of students development which might be improved by robot mediated learning. These objectives were to:

1.1. Identify the learning requirements of students with learning disabilities in different European countries

1.2. Describe the preferred teaching strategies of contemporary teachers working with students with learning disabilities, which are used to fulfill the particular requirements in partners countries;

1.3. Investigate teachers' practical experience with ICT usage in contemporary teaching practice

1.4. Identify the teachers' attitudes towards the use of robotics-based technology to stimulate the development of students with learning disabilities.

The literature search was the first step to reach these goals. Its results are presented below.

3. Learner Needs Literature Review

This section aims to summarise findings from an extensive literature review carried out across all partners examining the use of robots within education as examined in academia. In order to gain a consistent method of analysis in keeping with the aims of this particular report a coding sheet (see appendix B) was developed to identify areas of particular relevance to the EduRob project.

This coding sheet analysed literature for who the target groups for robotic interventions currently are, what their particular needs are, how robots can be used to meet those needs and what barriers have been identified that could impact on the introduction of robots as an intervention. The purpose of this report is to examine the student needs tackled in past research and to discuss the learning objectives used that measure success for such students when engaged with a robotic intervention. Furthermore, the potential impact robots can have on the learning process must be evidenced in order to justify the use of such interventions in a more longitudinal study.

3.1.Target Learners

Robotic interventions have been used to target a wide variety of individual learning needs, the most prominent of which appears to be those learners with Autism Spectrum Disorder (ASD). Such learners can typically have a wide variety of needs that impact on their ability to develop. They can, for example, have difficulty interacting with adults which makes engaging with a teacher difficult (Nikolopoulos et al, 2010). To expand, learners can have difficulty engaging and maintaining eye contact with peers (Park et al 2012), engaging in general social interactions such as play (Ferrari et al, 2010), general turn taking during conversation or other interactions (Cabibihan et al, 2013), engaging emotionally with peers and can require constant instruction and guidance (Dickstein-Fischer et al, 2011). Furthermore, such learners demonstrate a dependence on repetitive behaviours to manage their daily lives (Werry and Dautenhahm, 1999).

Such individual needs can make learning difficult particularly as a key skill to learning development includes imitating ones social peers and teachers (Dautenhahm et al, 2002). A difficulty in engaging with others as listed above reduces the likelihood of observing and therefore imitating others and hence impacts on the process of cognitive development.

Furthermore, it is worth noting that even with this specific disorder the range and severity of individual needs vary greatly across learners (Allison et al, 2011). This impacts on the teaching of such learners as this diversity must be taken into account when designing the teaching methods that must address the all prevalent needs. Indeed, Standen, Brown et al., (2014) focussed research on a learning cohort containing a range of individual needs with a number of learners demonstrating multiple and profound disabilities. Here the learners may not just exhibit issues with cognitive development but may also be physically impaired, requiring for example, the use of a wheelchair or other mobility aids.

The individual needs here could include difficulty in speaking, operating their mobility devices, issues with memory recall and understanding their teacher (Hedgecock, 2013). Again, addressing such needs through the teaching methods holds unique challenges in that they would appear to require individually tailored programmes but activities that are quick to set-up and implement for the teacher. Furthermore, in such instances where a range of severe disabilities are an issues, the learners may have issues with engaging in any form of the learning process; either with their peers or on an individual basis with the methods themselves (Encarnacao et al., 2013).

A further study of note demonstrates that regardless of the diagnosed disability the emerging symptoms across multiple disabilities may be similar. For example, Palsbo et al., (2012) notes that a number of such students have issues with handwriting and expressing their ideas through such a medium. It is likely that regardless of the disability the symptoms across SEN students will be similar to those noted in this review.

To summarise, current research appears to focus on ASD as a target audience for a robotic intervention; although a number of studies focus on multiple and profound disabilities. Such learners exhibit a variety of individual needs that must be catered for through appropriate teaching methods in order to minimise the impact they may have on development. However, doing so will require different measures of achievement for each learner based on their particular development needs. This is discussed in the following section.

3.2.Learning Objectives/Pedagogy

Typically in education, a defined learning objective (LO) is utilised to measure student achievement and to ascertain if a particular teaching session has been successful. However, the range of learning needs identified in the previous section implies that measuring success will be closely dependant on the individual learner. Indeed, it has been suggested that for students with ASD "individualised education programs are needed" (Akgun et al., 2012).

This is an approach adopted within a number of studies that consist of pilot trials of robotic technology. Within these trials the learning objectives became tailored to the individual needs of the student done in consultation with teachers who are familiar with the learners in question (Standen, Brown et al., 2014, Standen, Brown, Roscoe et al, 2014 and Roscoe, 2014). Here the learning objectives may include measure dealing with joystick control, the ability to hold an item, develop patience or to improve verbal communication. A study in the same vein held such learning outcomes as the ability to recall specifics from memory, identifying cause and effect, ability to follow direction and a demonstration of basic number work (Hedgecock, 2013).

This range of LO's demonstrate an eclectic mix of success measures. It should be noted that these particular students exhibit no one specific SEN and can have multiple and profound disabilities impacting on their learning. However, as reported earlier the same variety is prevalent even within ASD as studies that focus on this demonstrate.

Werry and Dautenhahm (1999), note that children with autism exhibit a dependence on repetitive behaviours in their daily lives. This dependence appears to be the basis for a number of learning outcomes used in other studies where the focus is on imitation and learning through replication. For example, Robins et al. (2005) notes that imitation plays an important role in developing social and instances of such indicate successful teaching. Furthermore, behaviourist pedagogical techniques are utilised, reinforcing behaviour through positive feedback (Cristoforis, Pedre et al., 2012).

Imitation is difficult to achieve for the reasons outlined earlier; namely, that SEN learners tend to be disengaged from their human peers and teachers, shying away from eye-contact or other direct social interaction. This has led to a number of studies focussing on the key components of encouraging social interaction that are present in typically developing learners. Park et al. (2012), used instances of eye contact, length of direct gaze and facial recognition as success measures for their sessions stating that these are core behaviours when people communicate and interact with others and being the most obvious ways of conveying emotion. Similarly, the lack of social engagement impacts learners' ability to play, another key development activity in children as it develops skills in communication and collaboration (Wainer et al., 2009). As such, a number of studies focus on increasing instances of "play behaviour" and such instances became LO's (Klein et al, 2014, Robins et al., 2005).

Finally, given the range of disabilities and relative attention spans that SEN student's exhibit, simply measuring increased engagement within the session forms an important LO for a number of studies. Engagement is described as the "single best predictor of learning" Roscoe, 2014) and could include instances of prolonged interaction and reduction in stereotypical autistic behaviour as success measures (Werry and Dautenhahm, 1999).

To summarise, this section has examined the ways in which SEN teaching is currently assessed within research focussing on robotic interventions. These LOs are necessarily complex and individually tailored given the individual needs found across the potentially diverse student cohort.

3.3. Impact of Robotic Interventions

Having examined the Special Education Needs and the accompanying Learning Objectives presented within literature, this final section examines the potential impact robots could have on the problem domain. This will be significantly expanded on in the report for D2.3 which focusses on the technical requirements a robotic intervention will need to have.

Robots are suggested as being a low-cost means for children with severe learning difficulties to demonstrate their cognitive abilities (Cook et al., 2012) and allow them to develop fine motor skills while also engaging in collaboration and teamwork (Sullivan et al., 2013).

This is due to a robots ability to form humanoid shape providing a “social bridge” to more substantial and long lasting social skill development aimed toward human peers and teachers (Caprino et al., 2010). Robots have the potential to further encourage collaborative learning by being the focal point of shared interests in a group; it is noted that children with autism tend to have natural curiosity of technology that enable it to become a powerful tool in encouraging the difficult social interactions that typically developing children learn most from (Wainer et al., 2009, Altin and Pedaste, 2013).

To this end, a number of studies have proposed the use of a robot as an ideal social mediator, taking the place of a teacher (who would most likely control the robot) in delivering the learning activity (Standen, Brown et al., 2014, Ferrari et al., 2010, Saerbeck et al., 2010, Patrizia et al., 2009). Indeed, it is suggested that children “accept the authority” of the robot (Fridin, 2014) and that they eliminate the complexity of interacting with humans (Nikolopoulos et al., 2010) that hinder the learning for SEN students.

Finally, robots are able to adapt to the diversity of the classroom due to the abundance of models available that each fulfil a variety of needs. Furthermore, each robot has a number of sensor inputs and accompanying outputs that tackle the specific needs of the learner if aimed appropriately. For example, the use of auditory and visual stimuli to engage users with ASD is shown as successful and popular (Allison et al, 2011). This allows students to explore the ideas of sensing and feedback and understand cause and effect (Rusk et al., 2008); a core skill and LO as specified earlier in this report. They have the potential to be a tutor, tool or peer (Mubin et al., 2013) due, in part, to their multi-modal interface offering multiple tactile ways of interacting with the intervention (Robins et al., 2005).

To summarise, literature suggests that robots are a potentially engaging medium for learners with SENs due, in part, to their natural curiosity of technology. This provides unique opportunities to offer learning interventions aimed at this target group that can aid in the social development in core areas that may have been lacking previously; for example, engaging in collaborative play or interacting with a teacher as a social mediator.

This literature review as a whole suggest that the target audience of robotic interventions holds a diverse set of potential requirements. Robots have the potential to address the full spectrum of these requirements from their on-board sensors and engaging nature. However, the question remains, to what extent does this diversity manifest itself within the for the target audience of this EduRob project. Such is the focus of the following survey results and discussion.

4. Methodology

4.1 Method

The Survey Questionnaire (English version) was created to measure the students requirements as well as teaching strategies employed by teachers so that these could be taken into account in the development of guidelines for the innovative use of robotics. The Questionnaire developed to gather quantitative data informing the students' is shown in Appendix A. The Questionnaire sought to gather data from key stakeholders in the learning process with a focus on teacher and therapists in special education.

The Questionnaire included questions dealing with the following areas:

a) professional characteristics (gender, age, teaching experience, ICT familiarity and usage in teaching practice),
b) students' characteristics (age, disability, support needed – described on the scale: 0=the lack of support needed, students active on their own, 1= with minimal help, 2=with considerable help, 3=students do not active at all).
c) students' educational and developmental requirements (at educational and social level) were analysed as following, perception, memory, thinking strategies, executive functions, communication skills, general knowledge and detailed knowledge, as well as basic key competences (such as: reading, writing, calculation, ICT).
d) teachers' teaching strategies in regular practice (such as: activity based teaching, learning through discovery, modelling, collaborative learning, instructional)

e) teachers' ICT familiarity and usage in teaching practice

f) teachers' attitudes towards robotics in education.

The Survey Questionnaire was translated into national languages and either filled in by respondents or by a researcher on behalf of the respondent(s) during a face to face interview or focus group.

4.2.Respondents profile

There were 272 questionnaires filled in total. The number from each country is given in Table 1.

Table 1. Number of Respondents per country collected by partners

Country/ Partner institution	Numbers of respondents	email/ internet	interview (face to face, Focus group)
Bulgaria/ Interprojects	52	0	52
Italy/ Europole	50	42	8
Lithuania/ Hiteco	52	52	-
Poland/ Pedagogical University	50	0	50
Turkey/ Sulyeman Sa University	50	10	40
UK/ Nottingham Trent University	18	8	10
TOTAL	272	112	160

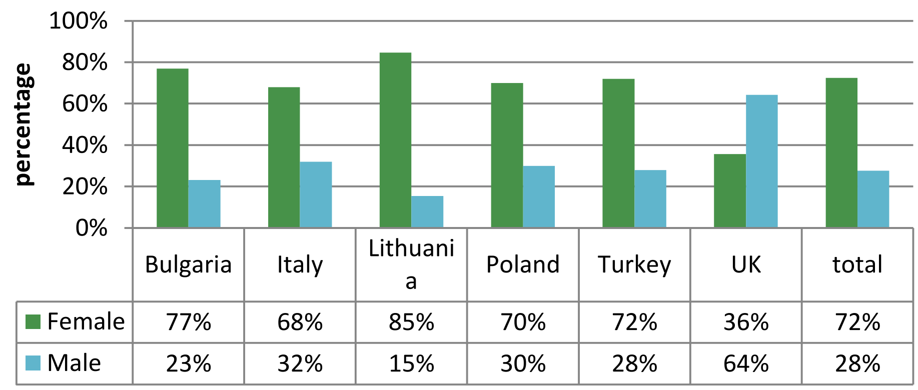
In the UK it was extremely difficult to get participants to complete the survey. NTU tried in multiple ways, beginning with contacting schools we have worked with in the past with the original version of the paper surveys, followed by email and social media mailshots with these. When this failed to yield the required numbers NTU asked some previous respondents why they thought this was. They cited the survey being too long and too complex, and not appropriate for the diversity of their students. NTU therefore created new simplified paper version of the survey, and also an online version of this in an attempt to decrease the workload and get some more results. This doubled the UK number of respondents, but unfortunately the total number of respondents obtainable was still only 18.

One respondent put this in the comment box. "This questionnaire isn't suitable for a fully comprehensive secondary school - all students have individual needs etc.- it's not just about teaching, it is how you are going to evidence progress. Any intervention needs to be targeted for the student. I read about the project last year - I think robots could be a fantastic way to get reluctant learners / learners with additional needs to be inspired by technology. As a SENCo working at a large secondary school with a technology specialism - we would be keen to trial any new and emerging technologies. – [email given] My apologies for being unable to complete this questionnaire - I understand that your project needs quantitative data, however feel this questionnaire isn't designed correctly. Feel free to contact me any time – [Name given]"

With this in mind, it seems that the method of using interviews with teachers would be respected much more highly in the UK. The methodology for WP3 involves this process, so the UK requirements will be captured in more detail at that stage.

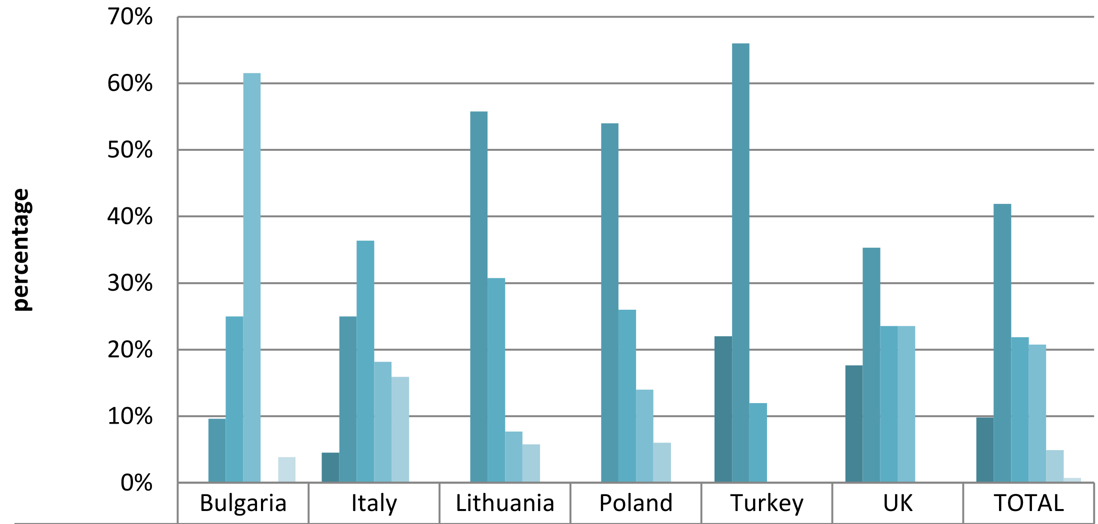
The total sample was dominated by females as were almost all national subgroups of participants with only one exception. In the UK there were more males in the tested subgroup (females -36%; 64% - males). The detailed gender differentiation is given in the Fig.1.

Figure 1. Gender of survey participants



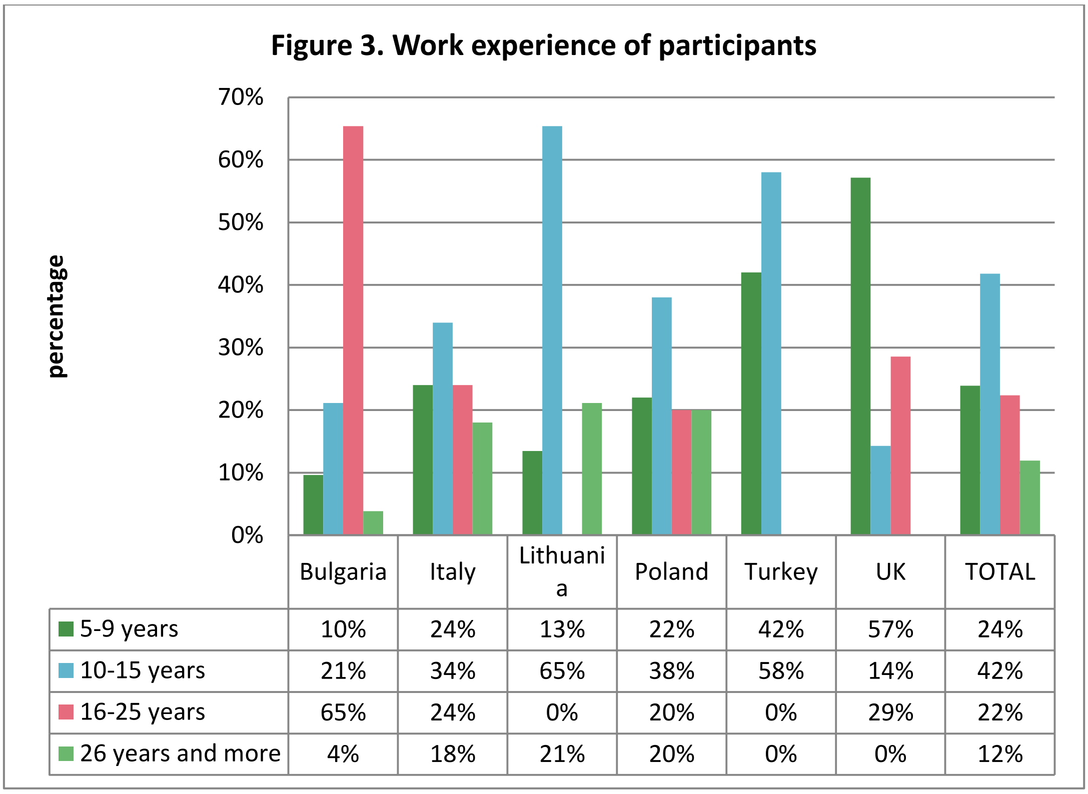
The respondents differed in age however young adults (aged between 25 and 35) represented more than 40% of the total sample. In five national samples most participants were also between 25 and 35 years however in two countries the majority of the participants were older. In Bulgaria over 60% of participants were aged over 45 years, and in Italy 70% were aged over 35. The detailed description of participants' age is given in the Fig. 2.

Figure 2. The age of survey participants



	Bulgaria	Italy	Lithuania	Poland	Turkey	UK	TOTAL
till 25 years	0%	5%	0%	0%	22%	18%	10%
25-35 years	10%	25%	56%	54%	66%	35%	42%
36-45 years	25%	36%	31%	26%	12%	24%	22%
46-65 years	62%	18%	8%	14%	0%	24%	21%
56-65 years	0%	16%	6%	6%	0%	0%	5%
>65 years	4%	0%	0%	0%	0%	0%	1%

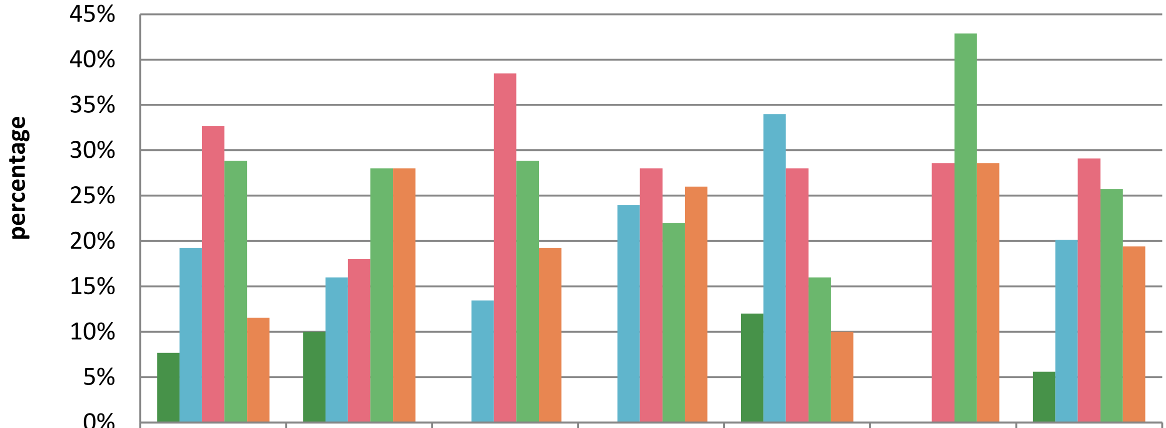
The survey participants differed in the length of time they had worked with students with learning disabilities. In the total sample over 40% of participants had work experience between 10 and 15 years. However in two countries the pattern was different. In England more than half of the subgroup had got shorter period of work experiences in contrast to Bulgaria where most of the participants were highly experienced having more than 16 years experience. The detailed data are given in the Fig. 3.



	Bulgaria	Italy	Lithuania	Poland	Turkey	UK	TOTAL
5-9 years	10%	24%	13%	22%	42%	57%	24%
10-15 years	21%	34%	65%	38%	58%	14%	42%
16-25 years	65%	24%	0%	20%	0%	29%	22%
26 years and more	4%	18%	21%	20%	0%	0%	12%

In the total sample familiarity with educational technology is pretty good (only 6% of respondents had none familiarity). However there is some international difference. A larger proportion of the UK subgroup had some familiarity with educational technology. In Poland, Bulgaria and Lithuania most participants declared fair familiarity with ICT in teaching practice however in Turkey for more than 30% of respondents familiarity was rather low. The detailed data of familiarity with ICT and educational technology in teaching practice are given in the Fig. 4.

Figure 4. ICT familiarity and usage in teaching practice



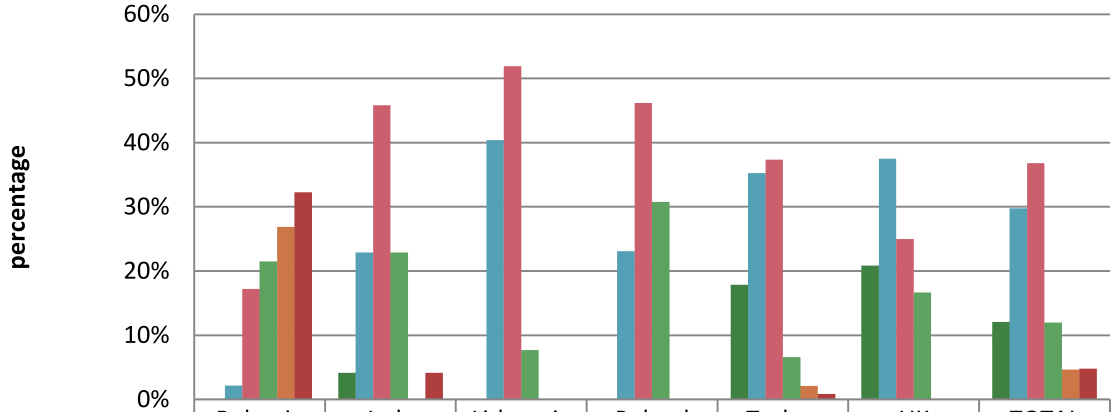
	Bulgaria	Italy	Lithuania	Poland	Turkey	UK	TOTAL
None	8%	10%	0%	0%	12%	0%	6%
Low	19%	16%	13%	24%	34%	0%	20%
Fair	33%	18%	38%	28%	28%	29%	29%
Good	29%	28%	29%	22%	16%	43%	26%
High	12%	28%	19%	26%	10%	29%	19%

5. Survey results

5.1. The age of students with learning disabilities with whom respondents worked

The professionals participating in the survey worked in different schools and centres for students with learning disabilities due to the differentiation of national educational systems and organisation practice in particular partner countries. The age of students with learning disabilities the survey respondents worked with varied. The detailed data are given in Fig 5. In the total sample nearly 70% of students taught by survey respondents were in the primary school age (6-15 years old) and this was similar in nearly all partner countries with only one exception. The Bulgarian students were older than those in the other subgroups.

Figure 5. The age of students survey respondents work with

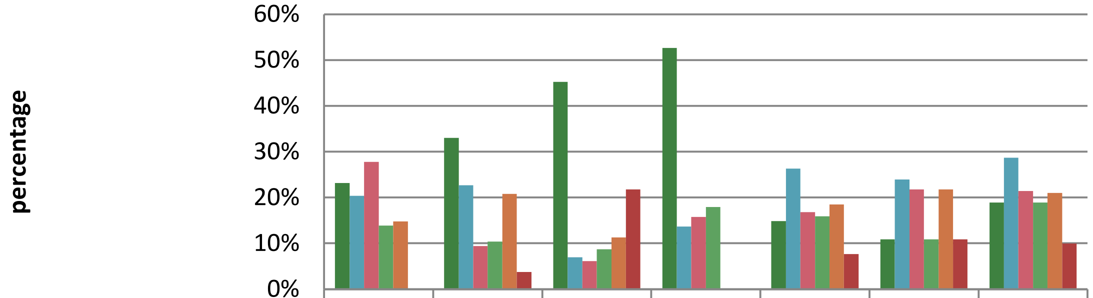


	Bulgaria	Italy	Lithuania	Poland	Turkey	UK	TOTAL
1-5 years	0%	4%	0%	0%	18%	21%	12%
6-10 years	2%	23%	40%	23%	35%	38%	30%
11-15 years	17%	46%	52%	46%	37%	25%	37%
16-20 years	22%	23%	8%	31%	7%	17%	12%
21-25 years	27%	0%	0%	0%	2%	0%	5%
over 25 years	32%	4%	0%	0%	1%	0%	5%

5.2. The disabilities of students the survey participants work with

In the total sample the most prevalent disabilities reported were intellectual disability, pervasive developmental disorders, sensory and motor impairments and learning difficulties and these groups were represented in the responses from nearly all partner countries. In Turkey, UK, Italy and Lithuania the group with which most respondents worked was intellectual disability. In the Bulgarian subgroup the group with which most respondents worked was students with sensory impairments. Detailed data are presented in Fig.6.

Figure 6. Disabilities of students the respondents work with



	Bulgaria	Italy	Lithuania	Poland	Turkey	UK	TOTAL
Intelectual Disability	23%	33%	45%	53%	15%	11%	19%
Pervasive Developmental Disorders	20%	23%	7%	14%	26%	24%	29%
Sensory Impairement	28%	9%	6%	16%	17%	22%	21%
Motor Impairment	14%	10%	9%	18%	16%	11%	19%
Learning Difficulties	15%	21%	11%	0%	18%	22%	21%
Other	0%	4%	22%	0%	8%	11%	10%

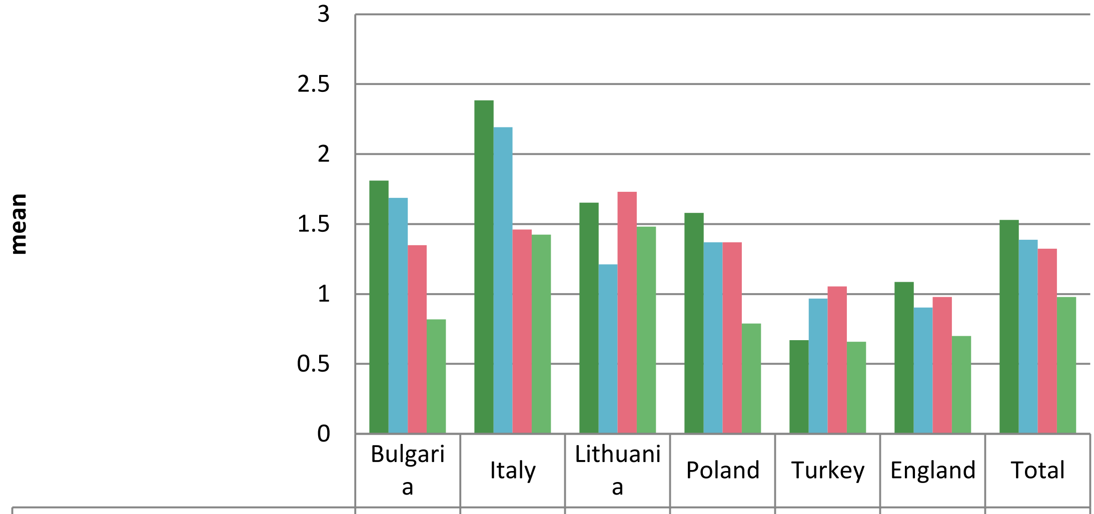
5.3. The level of support students need

The students requirements were analyzed in the context of the level of support needed to realize the teaching goals in particular (the cognitive and social) areas. In the total sample of students with learning disabilities the average level of support needed was congruent. It means that students needed slightly upper minimal help do deal with particular activities however on the one hand the more intensive support was required in learning and applying the knowledge and on the other the less intensive care was necessary in mobility.

If the particular functional area is compared two areas (learning and applying the knowledge as well as general tasks and demands) seem to be more support dependent areas than others especially in comparison to the mobility which was the activity realized on students own more fluently.

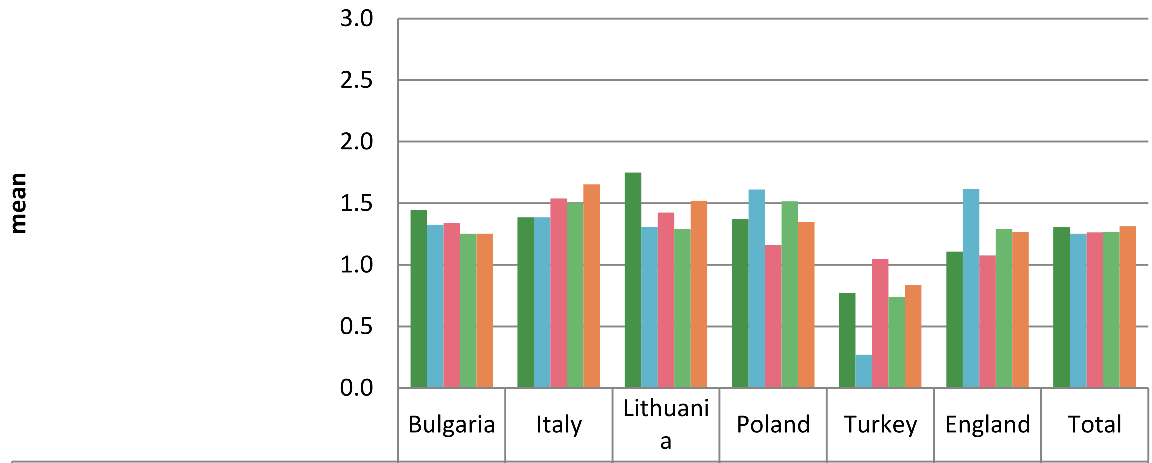
If the particular functional area are compared in the international context the national difference were found. In the two subgroups (Bulgarian and Turkish) the students needed the considerable support more often than in other subgroups especially in learning and general tasks however in Polish subgroup this level of support is required in communication self-care. The detailed data are presented in Fig. 7a and Fig. 7b.

Figure 7a. Average support needed



	Bulgaria	Italy	Lithuania	Poland	Turkey	England	Total
Learning skills	1.81	2.38	1.65	1.58	0.67	1.09	1.53
General Tasks and Demands	1.69	2.19	1.21	1.37	0.97	0.90	1.39
Communication	1.35	1.46	1.73	1.37	1.05	0.98	1.32
Mobility	0.82	1.42	1.48	0.79	0.66	0.70	0.98

Figure.7b Average support needed



	Bulgaria	Italy	Lithuania	Poland	Turkey	England	Total
Self-Care	1.45	1.38	1.75	1.37	0.77	1.11	1.31
Domestic Life	1.33	1.38	1.31	1.61	0.27	1.61	1.25
Interpersonal Relationships	1.34	1.54	1.42	1.16	1.05	1.08	1.26
Major Life Areas	1.25	1.50	1.29	1.52	0.74	1.29	1.27
Community, Social and Civic Life	1.25	1.65	1.52	1.35	0.84	1.27	1.31

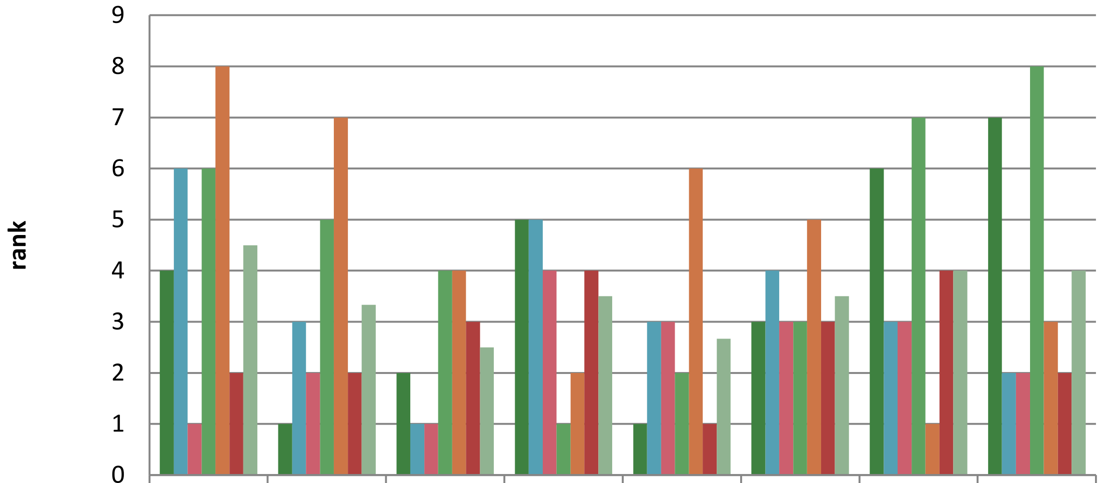
5.4. The students' requirements at the educational level

Respondents were also asked about their students' learning and developmental requirements in two separate domains: educational (Fig 8) as well as social (Fig 9). For each domain, they reported how many students required help with each of the cognitive skills listed and for each country cognitive skills were ranked according to the number of students respondents entered, so the cognitive skill with the most students was ranked 1,

For the total sample the cognitive skill with which the highest number of students required help was thinking strategies, at second position – communication, at third position memory, at fourth rank – executive function and general knowledge, at fifth position –detailed knowledge and basic key competences. The least number of students were recorded for perception.

Results from individual countries did not always follow this overall pattern. While the highest numbers of student were recorded for thinking strategies in Italy, Lithuania and Bulgaria, communication had the highest number in Bulgaria and UK. In Poland and Bulgaria the lowest numbers were recorded for basic key competences and detailed knowledge and in Turkey, Poland and Italy for perception. Respondents were also asked to indicate which cognitive skills they found most difficult to meet with current teaching strategies. Detailed data are presented in Fig. 8.

Figure 8. Hierarchy of students' learning and developmental requirements at educational level



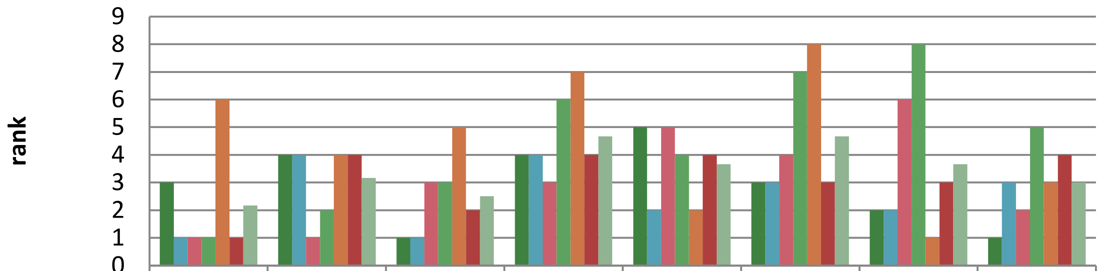
	Perception	Memory	Thinking strategies	Executive functions	Communication skills	General knowledge	Detailed knowledge	Basic Key competences:
Bulgaria	4	1	2	5	1	3	6	7
Italy	6	3	1	5	3	4	3	2
Lithuania	1	2	1	4	3	3	3	2
Poland	6	5	4	1	2	3	7	8
Turkey	8	7	4	2	6	5	1	3
England	2	2	3	4	1	3	4	2
Total	4.50	3.33	2.50	3.50	2.67	3.50	4.00	4.00

In general the most difficult to change and to improve are those cognitive skills which are limited in intellectual disability or PDD due to core developmental delay. Thinking strategies were reported as the most problematic and resistant to the educational and therapeutic processes by four of the six countries. The next most difficult cognitive skills for the teachers to deal with were detailed knowledge (Poland, England, and Italy), basic key competences (Bulgaria, Italy), perception (Lithuania), memory (Italy), and executive function (Turkey). The level of difficulty perceived by the teacher depends on the characteristics of the students they work with, their disability and core developmental delay as well as the intensity of the support they need.

5.5. The students' requirements at the social level

For the social level of students' requirements in the total sample the skill with which the highest number of students were reported as needing help was social learning, at second position – task management skills, at third position – mental persistence, at fourth rank – theory of mind ability, at fifth position – conscientiousness and sense of duty as well as knowing one's own pros and cons but the skills with the lowest number were accuracy and precision as well as self-presentation skills. Respondents were also asked to indicate which skills at the social level they found most difficult to meet with current teaching strategies. Detailed data are presented in Fig 9.

Figure 9. Hierarchy of students' learning and developmental requirements at social level



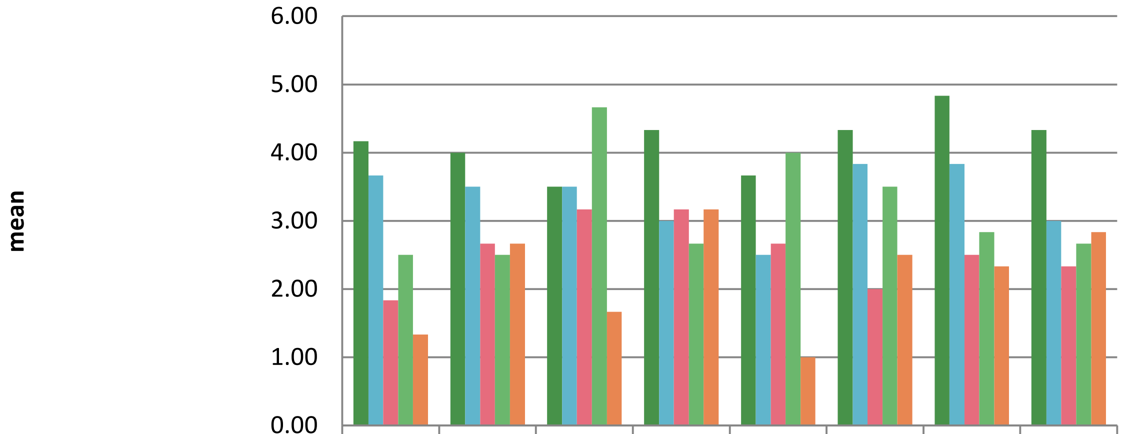
	Social learning	Theory of mind	Task management skills	Accuracy and precision	Conscientiousness and sense of duty	Self-presentation skills	Knowing one's own pros and cons	Mental persistence
Bulgaria	3	4	1	4	5	3	2	1
Italy	1	4	1	4	2	3	2	3
Lithuania	1	1	3	3	5	4	6	2
Poland	1	2	3	6	4	7	8	5
Turkey	6	4	5	7	2	8	1	3
England	1	4	2	4	4	3	3	4
Total	2.17	3.17	2.50	4.67	3.67	4.67	3.67	3.00

In general the social skills with which most students needed help are those which are limited in intellectual disability or PDD due to core developmental delay. These were mental persistence (Poland, Turkey, and Italy), task management (Bulgaria), social learning (Lithuania, Italy) and theory of mind (England). The next most difficult social skills for the teachers to deal with were self-presentation (Bulgaria, Lithuania), knowing one's own pros and cons (Poland, Turkey, Italy) and conscientiousness and sense of duty (UK) The level of difficulty perceived by the teacher depends on the characteristics of the students they work with, their disability and core developmental delay as well as the intensity of the support they need.

5.6. Teaching strategies in reference to the students requirements

Respondents were asked to report for how many children each of five teaching strategies were used for each of the skills and competences at the educational level and social level. Strategies were then ranked in terms of the number of children for whom they were used with number 1 being the strategy used for the highest number

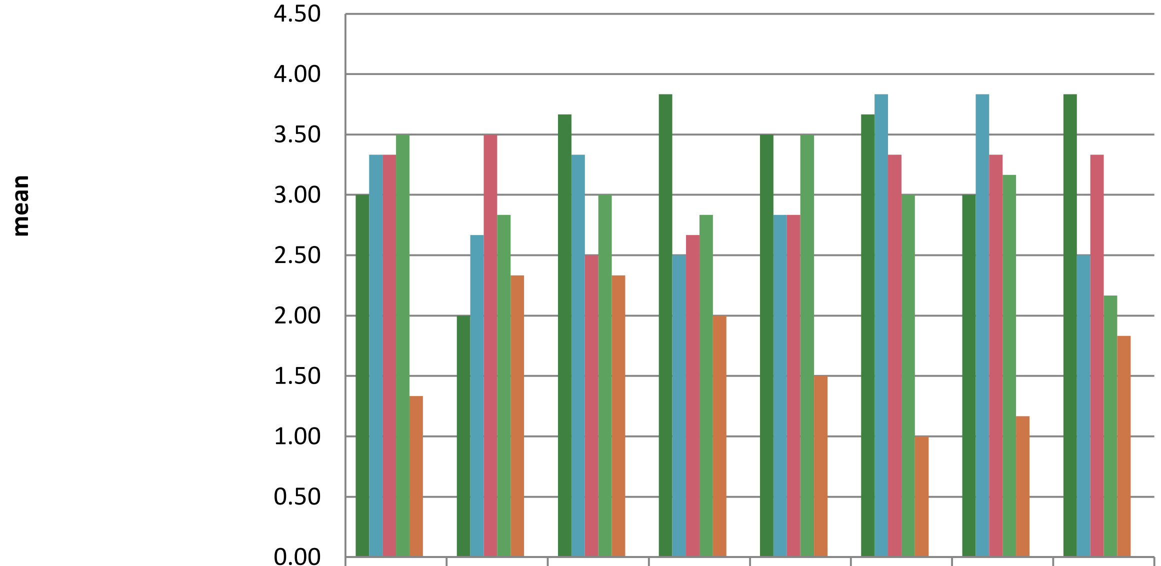
Figure 10a. The average intensity of teaching strategy use cognitive level



	Perception	Memory	Thinking strategies	Executive functions	Communication skills	General knowledge	Detailed knowledge	Basic Key competences
Activity based teaching	4.17	4.00	3.50	4.33	3.67	4.33	4.83	4.33
Learning through discovery	3.67	3.50	3.50	3.00	2.50	3.83	3.83	3.00
Modelling	1.83	2.67	3.17	3.17	2.67	2.00	2.50	2.33
Collaborative Learning	2.50	2.50	4.67	2.67	4.00	3.50	2.83	2.67
Instructional	1.33	2.67	1.67	3.17	1.00	2.50	2.33	2.83

Fig 10a above shows that activity based teaching is the most used teaching strategy for such cognitive skills as perception, memory, executive function, general and detailed knowledge and basic key competences. Collaborative learning was reportedly used for more children than was activity based teaching only for thinking strategies and communication. The second most used teaching strategy was learning through discovery probably due to most children being at the concrete stage of mental development.

Fig. 10b. The average intensity of teaching strategy use Social level



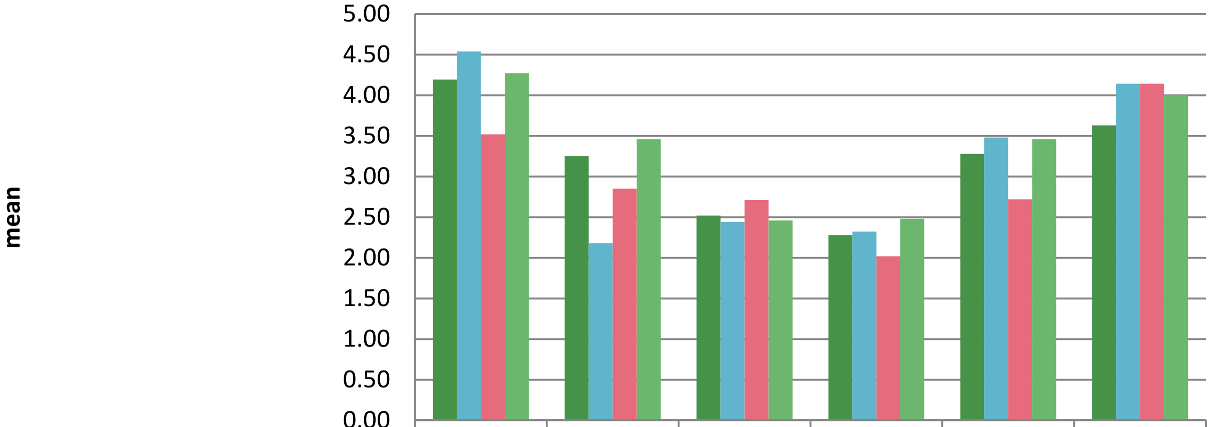
	Social learning	Theory of mind	Task management skills	Accuracy and precision	Conscientiousness and sense of duty	Self-presentation skills	Knowing one's own pros and cons	Mental persistence
Activity based teaching	3.00	2.00	3.67	3.83	3.50	3.67	3.00	3.83
Learning through discovery	3.33	2.67	3.33	2.50	2.83	3.83	3.83	2.50
Modelling	3.33	3.50	2.50	2.67	2.83	3.33	3.33	3.33
Collaborative Learning	3.50	2.83	3.00	2.83	3.50	3.00	3.17	2.17
Instructional	1.33	2.33	2.33	2.00	1.50	1.00	1.17	1.83

Fig 10b above shows that activity based teaching is the most used teaching strategy for such social skills as task management skills, accuracy and precision, and mental persistence. For conscientiousness and sense of duty activity based learning and collaborative learning were reportedly used for an equal number of children. However learning though discovery was reportedly used for the highest number for self-presentation skills and knowing one's own pros and cons competence.

5.7. School support for the use of robots in the classroom

New technology and new didactic methods need a supportive environment in order to be implemented in schools. The importance and the need of school support for the usage of robots in the classroom was analyzed in reference to the organizational as well as technological aspects perceived by respondents. The average importance of particular aspects of school support for robots in teaching practice were calculated. Results for organizational aspects showed some differences between countries (see Fig 11a). The school organizational culture was reportedly the most supportive for the inclusion of a robotics pedagogy in Bulgaria and UK, slightly lower in Turkey and Italy, with the lowest level of support reported in Poland and Lithuania. Staff were reported as being highly willing to use new methods also in Bulgaria and UK in contrast to Italy, Poland and Lithuania? where lower levels of support were reported. Higher levels of technical support for new technology were reported in England and Bulgaria in contrast to Poland. However openness to new methods in the school curriculum were reported as providing higher levels of support in England and Bulgaria in contrast to Poland where the school curriculum should be adjusted to the individual special needs but in general it is organized at national level.

Figure 11a. School support importance for the usage of robots in the classroom. Organizational aspects

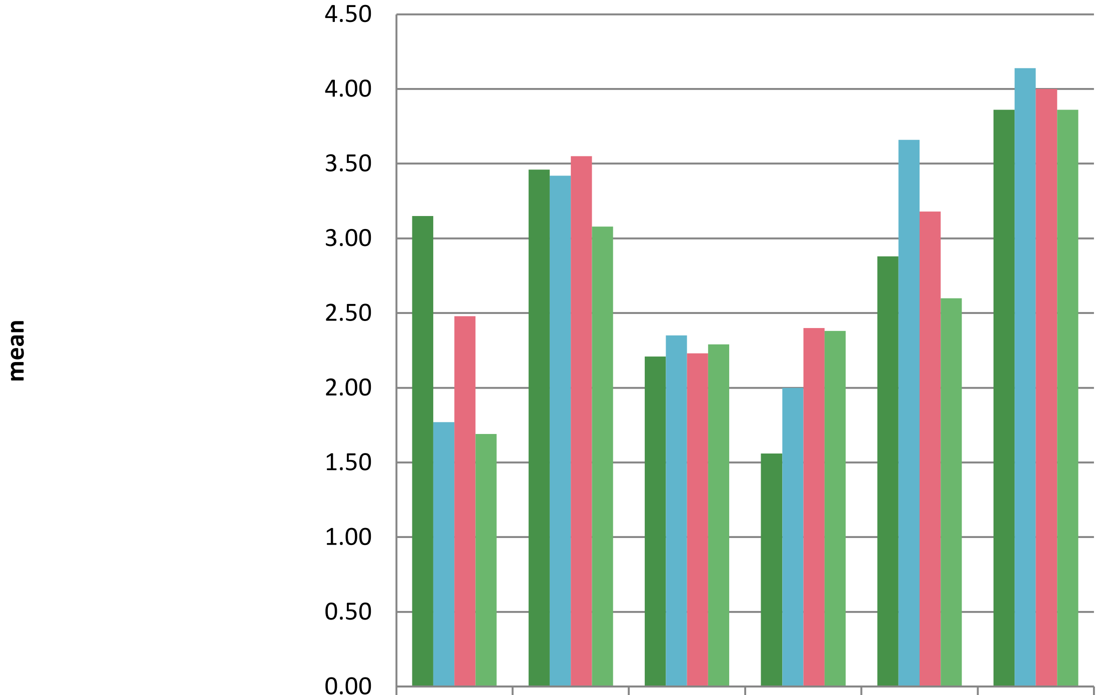


	Bulgaria	Italy	Lithuania	Poland	Turkey	England
School organizational culture	4.19	3.25	2.52	2.28	3.28	3.63
Staff willingness to use new methods	4.54	2.18	2.44	2.32	3.48	4.14
Technical support for the new technologies	3.52	2.85	2.71	2.02	2.72	4.14
Openness to new methods in the school curriculum	4.27	3.46	2.46	2.48	3.46	4.00

The new technology and new didactic methods also need technical support in order to be implemented in schools. The average importance of particular aspects of school support for robots in teaching practice were calculated. Results for technological aspects showed more differences between countries than there were for organizational aspects (see Fig 11b).

Higher levels of technical support aspects importance were reported due to experience in using new technology by UK teachers in contrast to Polish respondents. The national subgroups from Italy, Turkey and Lithuania) also pointed high importance of technological school support however respondents from Bulgaria were more differentiated in their opinion about particular aspects perceived. The reported level of support importance due to provision of high-tech equipment to control robots in the classroom as well as staff technical competence were higher in England, Italy and Turkey. However in the other three countries (Poland, Lithuania and Bulgaria) teachers reported significantly lower levels of support importance for these aspects. Technical support for the use of high tech equipment within school environment provided higher levels of support importance for teachers in England, Turkey and Italy in contrast to teachers from Poland, Lithuania and Bulgaria who find it difficult to get technical support for the usage of high tech equipment within particular school environment where they work.

Fig. 11b. School support importance for the use of robots in the classroom. Technical aspects



	Bulgaria	Italy	Lithuani a	Poland	Turkey	England
Staff experience in using new technological tools	3.15	3.46	2.21	1.56	2.88	3.86
School high-tech equipment provision to robot control in the classroom	1.77	3.42	2.35	2	3.66	4.14
Staff technical competence	2.48	3.55	2.23	2.4	3.18	4.00
Technical support for the use of high tech equipment within school environment	1.69	3.08	2.29	2.38	2.6	3.86

6. Scientific Conclusion

WP2 firstly aimed to describe the learning requirements of students with learning disabilities in the six different European countries and secondly to describe how these requirements are currently being addressed. The other core aim was to find the preferred teaching strategies of contemporary educators working with students with learning disabilities as well as their use of ICT technology tools in their teaching practice. This was the general basis for assessing teacher attitudes about the use of robotics technology to provide a significant impact on students' learning achievements.

The survey in six partners countries was conducted to meet these aims by administering the specially developed questionnaire. There were 272 questionnaires filled in total.

The results show that the age of students with learning disabilities the survey respondents worked with differed between countries. In the total sample nearly 70% of students taught by survey respondents were in the primary school age (6-15 years old) however in the Bulgarian subgroup students were older .

In the total sample the most prevalent disabilities reported were intellectual disability, pervasive developmental disorders, sensory and motor impairments and learning difficulties and these groups were represented in the responses from nearly all partner countries. In Turkey, UK, Italy and Lithuania the group with which most respondents worked was intellectual disability. In the Bulgarian subgroup the group with which most respondents worked was students with sensory impairments.

In the total sample of students with learning disabilities the average level of support needed and students needed slightly upper minimal help do deal with particular activities however on the one hand the more intensive support was required in learning and applying the knowledge and on the other the less intensive care was necessary in mobility.

At the social level of students' requirements the skill with which the highest number of students required help was social learning, at second position – task management skills, at third position – mental persistence, at fourth rank – theory of mind ability, at fifth position – conscientiousness and sense of duty as well as knowing one's own pros and cons but at the lowest importance was accuracy and precision as well as self-presentation skills.

The teaching strategies teachers use in reference to deal with cognitive skills improvement in the educational level show that activity based teaching is the most used teaching strategy for such cognitive skills as perception, memory, executive function, general and detailed knowledge and basic key competences. Collaborative learning was reportedly used for more children than was activity based teaching only for thinking strategies and communication. The second most used teaching strategy was learning through discovery probably due to most children being at the concrete stage of mental development.

At the social level activity based teaching is the most used teaching strategy for such social skills as tasks management skills, accuracy and precision, and mental persistence. For conscientiousness and sense of duty activity based learning and collaborative learning were reportedly used for an equal number of children. However learning though discovery was reportedly used for the highest number for self-presentation skills and knowing one's own pros and cons competence

7. Recommendations and implications for WP3

The development of **new pedagogy approach** is the advantage of people with learning disabilities due to the fact that robot seems to be patient and competitive teacher who stimulate engagement and social participation.

The robotic education might be engaged in development of many different cognitive and social skills. It might be effected in providing such activities as following areas: Imitation, Cause and Effect, Problem solving, communication, Social Learning, general and detailed knowledge, basic key competences.

The robotic education might have positive effect on cognitive and social development of different kind of disabilities (intellectual disability, pervasive developmental delay, sensory and motor disabilities as well as learning disabilities.

The procedure must be adapted to specialty of cognitive and social characteristic of particular disability.

As noted, the UK sample was smaller in size compared to other partners with the inability for the survey to address the complexity of the situation in schools there. This would suggest that there is a need for qualitative methods that explore such complexity allowing for depth of responses. Indeed, the aim of the WP3 is to utilise an interview protocol to explore current teaching methods in more detail. While this survey has demonstrated there is a range of needs that are to be addressed with the target cohort, it is unclear *how* they are currently addressed within teaching practices across partner countries. Hence, the aims of WP3 are to:

- Examine the impact of classroom diversity.
- Examine how that diversity is addressed.
- Gain teacher input into how robots could be used to address this diversity.
- Examine the barriers to the introduction of a robotic-based pedagogy.
- Use these points to create a pedagogy to guide the implementation of an intervention that is applicable across partner countries.

8. References

Akgun, Baris, et al. "Keyframe-based learning from demonstration." *International Journal of Social Robotics* 4.4 (2012): 343-355.

Wainer, Allison L., and Brooke R. Ingersoll. "The use of innovative computer technology for teaching social communication to individuals with autism spectrum disorders." *Research in Autism Spectrum Disorders* 5.1 (2011): 96-107.

Altin, Heilo, and Margus Pedaste. "Learning approaches to applying robotics in science education." *Journal of baltic science education* 12.3 (2013): 365-377.

Cabibihan, John-John, et al. "Why robots? A survey on the roles and benefits of social robots in the therapy of children with autism." *International journal of social robotics* 5.4 (2013): 593-618.

Besio, Serenella, Francesca Caprino, and Elena Laudanna. "Guidelines for using robots in education and play therapy sessions for children with disabilities." *Uniservice, Trento* (2010).

Cook, Albert M., et al. "The role of assisted manipulation in cognitive development." *Developmental neurorehabilitation* 15.2 (2012): 136-148.

Dautenhahn, Kerstin, and Aude Billard. "Games children with autism can play with Robota, a humanoid robotic doll." *Universal access and assistive technology*. Springer London, 2002. 179-190.

Dickstein-Fischer, Laurie, et al. "An affordable compact humanoid robot for autism spectrum disorder interventions in children." *Engineering in Medicine and Biology Society, EMBC, 2011 Annual International Conference of the IEEE*. IEEE, 2011.

Encarnação, Pedro, et al. "Using virtual robot-mediated play activities to assess cognitive skills." *Disability and Rehabilitation: Assistive Technology* 9.3 (2014): 231-241.

Ferrari, Ester, Ben Robins, and Kerstin Dautenhahn. "“Does it work?” A framework to evaluate the effectiveness of a robotic toy for children with special needs." *RO-MAN, 2010 IEEE*. IEEE, 2010.

Fridin, Marina. "Storytelling by a kindergarten social assistive robot: A tool for constructive learning in preschool education." *Computers & education* 70 (2014): 53-64.

Hedgecock, J.: Can working with a robot enhance learning in pupils with intellectual disabilities? B Med. Sci. Dissertation submitted to the University of Nottingham (2013)

Kärnä-Lin, E., K. Pihlainen-Bednarik, E. Sutinen and M. Virnes. Can robots teach? Preliminary results on educational robotics in special education. In: *Proceedings of the 6thIEEE International Conference on Advanced Learning Technologie*s (ICALT). Kerkrade, The Netherlands, July 5–7, (2006): 319–321

Klein, Tanja, et al. "Evaluation of short term effects of the IROMEC robotic toy for children with developmental disabilities." *Rehabilitation Robotics (ICORR), 2011 IEEE International Conference on*. IEEE, 2011.

Mubin, Omar, et al. "A review of the applicability of robots in education." Journal of Technology in Education and Learning 1 (2013): 209-0015.

Nikolopoulos, Chris, et al. "Socially assistive robots and autism." *Solid State Phenomena*. Vol. 166. 2010.

Park, Eunil, Ki Joon Kim, and Angel P. del Pobil. "Facial recognition patterns of children and adults looking at robotic faces." *International Journal of Advanced Robotic Systems* 9.28 (2012): 1-8.

Patrizia, Marti, et al. "A robotic toy for children with special needs: From requirements to design." *Rehabilitation Robotics, 2009. ICORR 2009. IEEE International Conference on*. IEEE, 2009.

Robins, Ben, et al. "Robotic assistants in therapy and education of children with autism: can a small humanoid robot help encourage social interaction skills?" *Universal Access in the Information Society* 4.2 (2005): 105-120.

J. P. Roscoe, "Can the use of a humanoid robot enhance the learning of children with learning disabilities?" 2014, bachelor of Medical Sciences, Honours Year Project Dissertation, The University of Nottingham

Rusk, Natalie, et al. "New pathways into robotics: Strategies for broadening participation." *Journal of Science Education and Technology* 17.1 (2008): 59-69.

Saerbeck, Martin, et al. "Expressive robots in education: varying the degree of social supportive behavior of a robotic tutor." *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, 2010.

Saerbeck M, Bartneck C. Attribution of affect to robot motion. In: *Proceedings of the 5th ACM/IEEE international conference on human-robot interaction* (HRI2010), Osaka, Japan, 2010

Standen, Penny, et al. "Engaging students with profound and multiple disabilities using humanoid robots." *Universal Access in Human-Computer Interaction. Universal Access to Information and Knowledge*. Springer International Publishing, 2014. 419-430.

Standen P, Brown DJ, Hedgecock J. et al., "Adapting a humanoid robot for use with children with profound and multiple disabilities". *in Proceedings of the 10th international conference on disability, virtual reality and associated technologies (ICDVRAT 2014)*. ICDVRAT. University of Reading, 2014. 205-211

Sullivan, Amanda, and Marina Umaschi Bers. "Gender differences in kindergarteners' robotics and programming achievement." *International journal of technology and design education* 23.3 (2013): 691-702.

Wainer, Joshua, et al. "The effectiveness of using a robotics class to foster collaboration among groups of children with autism in an exploratory study." *Personal and Ubiquitous Computing* 14.5 (2010): 445-455.

Werry, Iain, and Kerstin Dautenhahn. "Applying mobile robot technology to the rehabilitation of autistic children." *In: Procs SIRS99, 7th Symp on Intelligent Robotic Systems*. 1999.

Feuerstein, R., Feuerstein, R.S., Falik, L. & Rand, Y. (2006). The Feuerstein Instrumental Enrichment Program. Jerusalem: ICELP Publications.

Vygotsky, L. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Zawieska, K. , Duffy, B.R., (2014). The Self in the Machine. *Pomiary Automatyka Robotyka, 2,* 78-82, **DOI:** 10.14313/PAR_204/78

Appendix A - EDUROB SURVEY QUESTIONNAIRE

EDUROB: Educational Robotics for Students with Learning Disabilities

What is the age range of the students with Special Educational Needs and Disabilities that you currently work with, or have recently worked with? Please mark an x on the relevant line below:

1-5 years ____________________
6-10 years ____________________
11-15 years ____________________
16-20 years ____________________
21-25 years ____________________
>25 ____________________

Please describe the health condition of the students you work with by marking and x on the relevant line(s) below:

Intellectual Disability ____
Pervasive Development Disorder (e.g. Autism, Asperger's, Rett) ________________
Sensory Impairment ____
Motor Impairment ____
Learning Difficulties (e.g. Dyslexia) ___________________________________
Other ____

What levels of support do your students require for the following Activities & Participation? (In each cell of the table please put the approximate number of students you work with requiring this level of support from the total number of students you work with)

	On their Own	With minimal help	With considerable help	Not at all
Learning and Applying Knowledge				
General Tasks and Demands				
Communication				
Mobility				

Self-Care				
Domestic Life				
Interpersonal Interactions and Relationships				
Major Life Areas				

What are your students' learning and developmental requirements? (mark with an x the categories that correspond to your students)

	Qualities and skills	
A	**Educational level**	
1	Perception	
2	Memory	
3	Thinking strategies	
4	Executive functions	
5	Communication skills	
6	General knowledge	
7	Detailed knowledge	
8	Basic Key competences: reading, writing, calculation, ICT	
B	**Social level**	
1	Social learning	
2	Theory of mind	
3	Task management skills	
4	Accuracy and precision	
5	Conscientiousness and sense of duty	
6	Self-presentation skills	
7	Knowing one's own pros and cons	
8	Mental persistence	

What are the preferred teaching strategies of educators when working with students with special educational needs and disabilities for meeting the required learning and developmental requirements (please tick the most relevant one for each quality and skill in the table below).

Qualities and skills	**Activity based teaching**	**Learning through discovery**	**Modelling**	**Collaborative Learning**	**Instructional**	**Other? (Please state)**
Educational level						
Perception						
Memory						
Thinking strategies						
Executive functions						
Communication skills						
General knowledge						
Detailed knowledge						
Basic Key competences: reading, writing, calculation, ICT						
Social level						
Social learning						
Theory of mind						
Task management skills						
Accuracy and precision						
Conscientiousness and sense of duty						
Self-presentation skills						
Knowing one’s own pros and cons						
Mental persistence						

Which of the learning and developmental requirements in Qs. 4 and 5 do you find most difficult to meet with current teaching strategies? (please rank the 3 most difficult to meet using 1=most difficult, 2=next most difficult, and 3=third most difficult in section A and B)

	Qualities and skills	
A	**Educational level**	**Rank (1-3)**
1	Perception	
2	Memory	
3	Thinking strategies	
4	Executive functions	
5	Communication skills	
6	General knowledge	
7	Detailed knowledge	
8	Basic Key competences: reading, writing, calculation, ICT	
B	**Social level**	**Rank (1-3)**
1	Social learning	
2	Theory of mind	
3	Task management skills	
4	Accuracy and precision	
5	Conscientiousness and sense of duty	
6	Self-presentation skills	
7	Knowing one's own pros and cons	

8	Mental Persistence	

Please identify where you think educational technology, and **robotics** in particular, can help you meet the learning and developmental requirements of your students you have identified earlier in this survey.

	Qualities and skills	**Educational Technology (identify uses in the rows below from examples including interactive whiteboards, mobiles, iPads, games, virtual worlds, simulations, blogs, other)**	**Robots (please identify briefly how robots could meet these learning and developmental needs)**
A	**Educational level**		
1	Perception		
2	Memory		
3	Thinking strategies		
4	Executive functions		
5	Communication skills		
6	General knowledge		
7	Detailed knowledge		
8	Basic Key competences: reading, writing, calculation, ICT		
B	**Social level**		
1	Social learning		
2	Theory of mind		
3	Task management skills		
4	Accuracy and precision		
5	Conscientiousness and sense of duty		

6	Self-presentation skills		
7	Knowing one's own pros and cons		
8	Mental persistence		

What aspects of your organisation might support the use of robots in the classroom? Please indicate what level of support might be provided by each of the following aspects with a rating of 1- 5 (1 = No support to 5 = High level of support)?

	Aspects	**Support Rating (1 to 5)**
A	**Organizational Aspects**	
1	Your organizational culture	
2	Staff willingness to use new methods	
3	Technical support for the new technologies	
4	Openness to inclusion of new methods in the school curriculum and IETP (Individual Educational and Training Plans)	
B	**Technological Aspects**	
1	The level of staff experience in using new technological tools	
2	The level of school provision of high-tech equipment (e.g., tablets and laptops) that would allow the control of robots in the classroom	
3	The level of staff competence	
4	The level of technical support for the use of high tech equipment within your school environment	

Please provide any other comments that you think might be helpful in terms of using robots to help your students meet their learning and developmental requirements

e.g. problems experienced; current challenges not overcome with current strategies; financial obstacles;

About You

What age range are you within? (Below 25 years, 25-35 years, 36-45 years, 46-55 years, 56-65 years, Above 65 years) ___________________

Are you male or female? ___________________

How long have you been teaching in SEN? (0-5 years, 6-15 years, 16-25 years, 26 and more years)
____

How familiar are you with educational technology (please rate your skills regarding the use of the most common technological teaching tools, e.g., interactive whiteboards, iPads, mobiles, games, virtual worlds, simulations, e-portfolios, etc, from the following levels:
[None (Have never used any educational technology), Low, Fair, Good, High (confident in using a wide range of education technology)]____

Thank you very much for completing this survey. If you would like to keep up to date with the project, or receive any more information please go to http://edurob.eu/
If you would be interested in participating in piloting of the developed resources please do not hesitate to contact andy.burton@ntu.ac.uk .
Or add your email address here: ____

Please return this survey to: andy.burton@ntu.ac.uk or printed surveys may be returned to:
Andy Burton, RFB102, Clifton Campus, Nottingham Trent University, Clifton Road, Nottingham NG11 8NS.

Appendix B - EDUROB Coding sheet to be used for all literature reviewed.

Name and Organisation of Reviewer:

Paper title:

Author:

Author background:

Type of paper (study, discussion paper, product description, literature review, etc.):

Target group:

Barriers to use identified in the paper (organisational, technological, educational, social):

Study type (single case study, uncontrolled cohort, controlled cohort), learning objectives, outcome measures and conclusions, did authors rely on any pedagogical theory, criticisms of the paper (e.g., cohort too small, paper written by a manufacturer?):

Findings of the paper related to the specific questions of our literature review:

Present and future trends for technology identified by paper	
What types of students are robots currently used for in this paper?	
What Learning Objectives are robots used for in Special education in this paper?	
Is the use of robots in special education driven by any pedagogical theory in this paper?	
Are any barriers identified to the use of robots in special education in this paper?	
Has the study in this paper been objectively evaluated?	
Are there any other observations you would like to make about this paper and its findings/results?	