"AI-TOP - An AI Tool to Predict Engagement and Meltdown Events in Students with Autism"

Project Number: 2020-1-UK01-KA201-079167

AI-TOP

Intellectual Output 5:
"The AI-TOP Pedagogic Framework"

Authors:
University of Thessaly, PhoenixKM and
Nottingham Trent University

Table of Contents

Acronyms / Vocabulary

ACRONYM	EXPLANATION
AI-TOP	The project – "An AI Tool to Predict Engagement and 'Meltdown' Events in Students with Autism"
OS	Operating System – the platform running on the device, such as Windows 10, Android etc.
ASD	Autistic Spectrum Disorder

1 Introduction

Core to the AI-TOP project is supporting classroom diversity and providing effective tools that can detect engagement and onset of emotional dysregulation events in students with a wide range of abilities, and pass this information on to their teachers in a useful and helpful way. This means training the algorithm across a wide range of profiles of abilities and needs, so that its predictions in terms of the emotional states of students related to learning are accurate, reliable and unbiased

This training should allow the software to recognise each student's emotional states related to learning (e.g. engagement, boredom and frustration), as well as states related to behavioural arousal (e.g., rumble and meltdown) which may lead to classroom disruption. .

Ensuring that the outputs of our project are suitable for deployment in inclusive classrooms was of prime important and the research undertaken highlighted that the hardware currently available in the schools across Europe would be limited to lower end devices, mainly running windows with a USB webcam functionality.

Teachers are unlikely to have been trained in the use of emotion recognition systems before, so it is essential that the consortium sets out appropriate guidance to allow its successful use in the classroom.

Additionally, adopting computer based emotional tracking approaches may allow trainers to re-examine their traditional didactic roles and adopt a different stance: allowing more freedom to interact with other students in the room for example, enabling better distribution of their close monitoring so that more students are supported to reach their full potential

The role of the educational and pedagogical framework is to provide trainers with a blueprint on how to optimally use the AI-TOP tools and resources, making use of the provided emotion detection software and the teacher facing mobile interface which will inform them when events that are importance to student success are detected by the desktop system, and when intervention is deemed appropriate

Objectives of the framework:

- To secure the implementation of AI-TOP project and its outputs, i.e., to encourage teachers to use it and to use it appropriately.

- To provide guidelines that will enable implementation for a wide spectrum of schools and other training environments.

The stakeholders and beneficiaries of the AI-TOP project will vary considerably in requirements and abilities, so while there are general pieces of advice and good practice that will apply in many learning environments, we cannot always be prescriptive in how AI-TOP should be used. For this reason, the framework provides dimensions that can generate directives and questions. A directive is like an instruction, i.e. telling someone what they should do, for example "the organisation must be supportive of the introduction of AI-TOP and possess an appropriate pedagogic culture". Directives are made based on evidence that suggests this advice is good for a range of trainees and learning environments. This is in contrast to situations where the trainer has to make up their own mind because only they know the situation in which they are using the AI-TOP project resources. For these eventualities, the framework

provides prompts with questions such as "What are realistic engagement goals for this trainee?" The diagrammatic representation of the framework in Annex 1 gives questions and directives for each dimension. Although questions are posed for the trainer to answer in the way they know best fits their environments and trainees, some of the questions have directives provided to assist trainers to answer those questions.

1   Structured Interviews to Elicit User Requirements

A paper was published on this work in HCII 2022 describing the collection of data from our stakeholders on their attitudes and perceptions regarding the use of multimodal data and explainable AI to support the best academic and behavioural outcomes for students with autism in inclusive classroom settings:

Turabee, Z.B. *et al.* (2023). The Use of Explainable Sensor Systems in Classroom Settings - Teacher, Student and Parent Voices on the Value of Sensor Systems. In: Antona, M., Stephanidis, C. (eds) Universal Access in Human-Computer Interaction. HCII 2023. Lecture Notes in Computer Science, vol 14021. Springer, Cham. https://doi.org/10.1007/978-3-031-35897-5_33

Below we present a summary of the published work.

1.1   Need for multi-modal systems for children with autism?

Children with Autism Spectrum Disorder (ASD) experience difficulty in expressing their mental and emotional states, and understanding those of others. This may be caused by sensory overload, emotional overload, or cognitive overload. A system which is able to predict and detect any early signs of an emotional dysregulation would therefore be a useful addition to alert the relevant guardian or staff member.

The aim of the AI-TOP project is the specification of an App which is able to predict the "rumble" moments (early signs of emotional dysregulation) in children with ASD. This App will be able to detect early signs of an emotional dysregulation event, sometimes termed a "meltdown" event, increase the engagement rate of students with autism in classrooms and to increase their overall quality of life and mental and emotional well-being of those students and teaching staff who support them.

1.2   Interviews - Partners and Participants

Interviews were conducted across the AI-TOP consortium, and with a broad range of relevant participants. The breakdown of this data is given below:

By Institution:

- 11 from the NTU(UK)
- 5 by UNITH (Greece)
- 6 from STPH (Bulgaria)
- 2 from NARHU (Bulgaria)
- 4 from PhoenixKM (Belgium)

By demographic:

- 8 mainstream education workers
- 7 specialist education workers

- 11 parents of autistic persons
- 2 autistic persons

The interviews were carried out using a 'structured interview' approach. Questions were asked in a formal way following the topics listed below:

- Child's profile
- Experiencing a meltdown
- Educational Setting
- Technology
- Data collection
- Feedback

1.3 Thematic Analysis

ASD can manifest very differently from child to child. There are some common traits that children show before the onset of rumble phase. We need to be able to recognise the behavioural perspective of meltdown and its triggers. In order to try and understand this we performed Thematic Analysis on the interview data[12] parents, teaching staff, caregivers and people with autism themselves about their experiences.

Primary Themes that we asked them about were:

- Factors that cause Dysregulation
- Manifestations of Dysregulation in Behaviour
- Acceptance issues with Potential Systems
- Legal and Ethical issues with Potential Systems

The full Thematic Analysis applied to the data gathered from the interviews described above are appended to this document as Annex 1. The structured interview protocol is included with this document as Annex 2.

1.4 Factors that cause dysregulation

Below we list some quotes identified in the interviews which describe important factors which may cause dysregulation events.

---

[1] Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, *3*(2), 77-101.

[2] Braun, V., & Clarke, V. (2022). Conceptual and design thinking for thematic analysis. *Qualitative Psychology*, *9*(1), 3.

1.4.1 Unexpected Changes or Tasks

"The plan for the day is fine. It's got to have make sure he knows what he's doing for that day and if the if it changes, then it then he'll get stressed out won't you? but it you just depends on what pops up to cause the problem." – (Parent)

"Yes, of course. This is something he tells me to do. We have started doing it (informing him what comes next) since he was younger and he demands it now. That is, he tells me "tell me now what we are going to do"." – (Parent)

"More often when we are outdoors, rarely at home and occurs when there is a change in the normal rhythm of the day and daily routine tasks." – (Parent)

1.4.2 Environmental factors

"He was mainly bothered by the textures in the fabrics, for example he did not have any clothes with a label when he was younger. I mean with the soft part of the tab. He was also disturbed by the repetitive noises or the repeated tones, voices etc. These mainly......and sometimes some smells." – (Parent)

Noise from other students:

"We had, we had, we nearly had a meltdown this afternoon because of another student was having a tricky time. We had to come out the classroom." – (Teacher)

1.4.3 Delayed processing

"Well, we could say as well that the causes you know lots of our children have really delayed perception, so something might happen 2 hours, 5 hours 3 days beforehand and their processing time is is that long. So it might be that they're sitting in our classroom and they're actually worrying about something that happened 3 days ago, and you know, and it's displaying over and over and over in their mind. And it has probably been playing over for three days. It suddenly gets the point where they can't cope with that anymore, and so that's when they become dysregulated."

1.5 Manifestations of dysregulation behaviours

1.5.1 Pre-dysregulation/Rumble Moment

"…You know, the way they're blinking might be different. For example, I've got one child who develops creases on his face and the day before he's going to have a melt…, you know, meltdown as you call them…" – (Teacher)

"So a couple of them the one this afternoon he was having to he'd got hands on ears because it was too loud. A couple of them would have hoods and will pull hoods up again to do that. And a

couple of mine make noises they will hum a make sounds to drown out some of the other noises."
– (Teacher at special school)

1.5.2   Dysregulation/Meltdown

"And so some of it will be physical. So we'll have we've got scratching, hitting, biting, kicking. Screaming, some of them will cry. I've got one or slam himself onto the floor. One he likes to try and abscond, spitting." – (Teacher)

"It can be crying and and self self harm. So one student will just keep biting himself or hitting his head lots of crying and just really distressed. Uh, another student to it could be lashing out at another." – (Teacher at special school)

1.6   Acceptance issues with potential systems

1.6.1   Technology

"They're great on iPads. A few of them use iPads to communicate as well. And so they're really good at that. They use laptops in ICT" - (Teacher)

"iPads are by far the most popular. Everybody loves iPads, everybody fights over getting the iPads. I think teachers are very positive about them as well and. There, they're just. They're very intuitive because of the touch screen and children who really have no speech, no literacy, no ability to type or. Spell. They can operate iPads to quite an astonishing level in terms of, you know, navigating between different screens, open and closing apps, etc. And. And schools especially, I think have come on board because of all the AAC apps, the augmented of alternative communication, that's sort of brought up pedagogical use to them." – (Parent of 2 children with ASD who is also an expert and researcher into ASD)

1.6.2   Attitude towards mobile phones, cameras, wearables

"The other thing is… some children don't like labels or clasps, or buttons, or anything along those lines. My Fitbit has got, you know at buckle on it, that probably isn't gonna work. You also need to think about the weight for example. Could it be used as a weapon? And if they managed to get it off, is there anything like this pointy bit of my bit that goes through the buckle?." – (Teacher)

"I'm not sure how we would cope with sort of like anything like chest straps or things being stuck to our bodies. We might tolerate wristbands and watches, definitely iPads, microphones. I don't think they'd be overly aware of being there." – (Teacher)

1.6.3   Feedback to the teacher

"Yeah, probably not vibrating. I don't. I'm not sure that's really a good idea, but really as simple as possible because we just do not have time to read data and so something as simple as you know the child's initial and a traffic light system" – (Teacher)

"I think the best way is the application to signal through notifications, so that we can react immediately and the parent or the teacher can access the information through a dashboard. Since I think that the dashboard information is very complete and detailed and one could receive it in the form of a diagram, we could immediately find out what is happening to the child" – (Teacher, who is also the parent of an atypical autistic child)

1.7 Legal and Ethical issues with Potential Systems

1.7.1 Parental Consent

"I think there'd certainly be a few parents that would be happy with that. There might be a few that'd want an in-depth chat with you guys about what, it's in aid of... But yeah, I think generally there they… " - *(Teacher)*

"So we'd have to get GDPR permission for parents, and we've got parents who will not… you know you get one parent in a class that refuses and that's it for the class." – (Teacher)

1.7.2 Data Safety

" I think that's positive in itself, and I assume that privacy is protected as much as possible." – (Teacher)

"If this device can be shown to having a great benefit to us if we can be assured that data isn't being recorded. If we're showing that it's being only used in real time, and then it disappears, that makes it a little bit of a different prospect."– (Teacher)

"Personally no... not particularly. That's because I am in favour of using such data for research purposes only. So for me there has to be a recording in a safe context. It is necessary to record and to analyse the data and then little by little to have the system ready in order to put the appropriate tools. "–(Teacher)

1.8 Conclusions

Breaking down the above collected quotes on the identified relevant themes leads us to a number of conclusions about implementation of our AI-TOP system. These are summarised below:

- Individual persons with Autism have distinct and identifiable signals before and during the early stages of dysregulation

- Causes of dysregulation appear to be consistent amongst those interviewed

- Potential users of the system, particularly in the UK, have data security concerns and concerns regarding the potential for the data to be abused in terms of evaluating staff performance

- Students are likely to have widely varying tolerances to wearables, cameras, microphones, and other data sources

These factors lead us to the conclusion that there is a specific need for **multi-modal system** in order to allow the best possible tracking of a wide variety of users with distinct needs.

2   The AI-Top Pedagogical Framework

2.1   Definition:

ASD is a neurodevelopmental disorder characterised by difficulties in communication, social interaction, and repetitive patterns of behaviour. It is a spectrum disorder, which means that it can vary widely in its presentation and severity from person to person. This developmental disorder affects how a person perceives, processes, and responds to information from their environment. It typically becomes apparent in early childhood and persists throughout a person's life.[3]

2.2   Symptoms:

The symptoms of ASD can vary significantly from person to person, but they generally fall into two main categories: social communication difficulties and repetitive behaviours or restricted interests. Some common symptoms of ASD include:

Social communication difficulties: People with ASD may have difficulty with verbal and nonverbal communication, such as maintaining eye contact, understanding social cues, and responding appropriately to social interactions. They may also have difficulty with using and understanding gestures, facial expressions, and body language.

Repetitive behaviours or restricted interests: People with ASD may engage in repetitive behaviours, such as repeating the same actions or phrases, sticking to strict routines, or becoming intensely focused on specific interests or activities. They may also show resistance to change and have difficulty adapting to new situations or environments.

Diagnostic Criteria:

The diagnostic criteria for ASD are outlined in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5)[4], which is widely used by healthcare professionals for diagnosing mental health disorders. According to DSM-5, the diagnostic criteria for ASD include:

Persistent deficits in social communication and social interaction across multiple contexts, as manifested by difficulties in social-emotional reciprocity, nonverbal communication, and developing, maintaining, and understanding relationships.

Restricted, repetitive patterns of behaviour, interests, or activities, as manifested by at least two of the following: stereotyped or repetitive motor movements, insistence on sameness, highly restricted interests, and hyper- or hyporeactivity to sensory input.

The symptoms must be present in early childhood but may not become fully manifested until later in life. The symptoms must cause significant impairment in social, occupational, or other areas of functioning.

---

[3] https://www.nimh.nih.gov/health/topics/autism-spectrum-disorders-asd

[4] https://www.psychiatry.org/psychiatrists/practice/dsm

2.3 Functionality:

The functionality of individuals with ASD can vary greatly depending on the severity of their symptoms and the level of support they receive. Some individuals with ASD may have relatively mild symptoms and may be able to lead independent lives, while others may require significant support in their daily activities.

Functional levels in ASD are often described using a system called the Autism Spectrum Rating Scales (ASRS)[5], which categorises individuals into four levels:

Level 1 (Requiring support): Individuals with Level 1 ASD may have mild social communication difficulties and repetitive behaviours, but they can generally function independently with some support.

Level 2 (Requiring substantial support): Individuals with Level 2 ASD may have moderate social communication difficulties and repetitive behaviours and may require more substantial support in their daily activities, such as assistance with planning and organisation.

Level 3 (Requiring very substantial support): Individuals with Level 3 ASD may have severe social communication difficulties and repetitive behaviours and may require very substantial support in their daily activities, including assistance with personal care and supervision.

Level 4 (Requiring very high support): Individuals with Level 4 ASD may have extremely severe social communication difficulties and repetitive behaviours and may require constant support and supervision in their daily activities.

It's important to note that individuals with ASD are unique and may have strengths and challenges that are specific to them. With appropriate support, many individuals with ASD can lead fulfilling lives and make meaningful contributions to their communities. Early diagnosis, intervention, and support are crucial in helping individuals with ASD reach their full potential. Various interventions and therapies, such as behavioural therapy, speech and language therapy, occupational therapy, and social skills training, can be beneficial in addressing the core symptoms of ASD and improving functional abilities.

In recent years, there has been a growing emphasis on promoting neurodiversity and inclusion, recognising that individuals with ASD and other neurodevelopmental disorders have unique strengths, talents, and perspectives to offer. Many individuals with ASD excel in fields such as science, technology, arts, and advocacy, showcasing the diverse abilities and contributions of individuals on the autism spectrum.

It is important to note that the functional abilities and needs of individuals with ASD can change over time. With appropriate support, many individuals with ASD are capable of progress and development, and may experience improvements in their social communication skills, adaptive behaviours, and overall quality of life.

However, it's also important to acknowledge that individuals with ASD may face challenges in various aspects of life, including social interactions, employment, education, and mental health. It is crucial to provide ongoing support, understanding, and acceptance to individuals with ASD, and to work towards creating inclusive environments that accommodate their unique needs and differences.

In conclusion, ASD is a complex neurodevelopmental disorder that affects communication, social interaction, and behaviour. It is a spectrum disorder with a wide range of symptoms and functional abilities. Early diagnosis, intervention, and support are essential in helping individuals with ASD thrive and reach their full potential. By promoting neurodiversity, inclusion, and understanding, we can create a more

---

[5] https://www.pearsonclinical.co.uk/store/ukassessments/en/pragmatic/Autism-Spectrum-Rating-Scales/p/P100009046.html

inclusive and accepting society that embraces the unique strengths and contributions of individuals with ASD.

2.4 Meltdowns

Meltdowns, also known as autistic meltdowns, sensory meltdowns or emotional dysregulation, are intense behavioural reactions that may occur in individuals with ASD. These meltdowns are typically triggered by overwhelming sensory stimuli or a build-up of stress or anxiety, and can manifest as outbursts, tantrums, or other challenging behaviours. Understanding the role of triggering factors in meltdown events in autism is important for caregivers, educators, and individuals with ASD themselves, in order to prevent and manage meltdowns effectively.

Sensory Overload: Sensory overload occurs when an individual with ASD becomes overwhelmed by sensory stimuli such as loud noises, bright lights, strong smells, or tactile sensations. The sensory input may become too intense for the person to process, leading to a meltdown. For example, a crowded and noisy environment, such as a busy shopping mall, may trigger sensory overload and result in a meltdown.

Changes in Routine or Environment: Individuals with ASD often thrive on routine and predictability. Any changes in their routine or environment, such as unexpected schedule changes, transitions, or disruptions to familiar routines, can be triggering and lead to meltdowns. This may include changes in daily activities, a new environment, or disruptions in familiar schedules, which can disrupt the individual's sense of predictability and stability.

Communication Difficulties: Communication challenges are common in individuals with ASD. When they are unable to effectively communicate their needs, wants, or feelings, it can lead to frustration, anxiety, and meltdowns. Difficulty in expressing themselves verbally or understanding social cues, as well as challenges in using nonverbal communication, can be triggering factors for meltdowns.

Emotional Regulation Challenges: Individuals with ASD may have difficulty regulating their emotions, which can contribute to meltdowns. They may struggle with identifying and managing their emotions, and may become overwhelmed by intense emotions such as anger, fear, or frustration. This can result in meltdowns as a way of expressing or coping with overwhelming emotions.

Sensory Sensitivities: Many individuals with ASD have heightened sensory sensitivities, which means they may be overly sensitive to sensory stimuli in their environment, such as bright lights, loud noises, certain textures, or strong smells. These sensory sensitivities can trigger meltdowns as the overwhelming sensory input becomes too much for them to handle.

Anxiety and Stress: Anxiety and stress are common among individuals with ASD, and high levels of anxiety or stress can act as triggers for meltdowns. The build-up of anxiety or stress, whether related to social situations, changes in routine, or other factors, can overwhelm individuals with ASD and result in meltdowns as a response to the heightened emotional state.

It's important to note that the triggers for meltdowns can vary greatly from person to person with ASD, and what may trigger a meltdown in one individual may not affect another in the same way. Therefore, it's

crucial to understand and identify the individual triggers for meltdowns in each person with ASD and work on developing strategies to manage and prevent meltdowns based on their unique needs and sensitivities. This may include developing sensory strategies, using visual supports, promoting effective communication, providing predictable routines, and teaching emotional regulation skills. Collaborating with professionals such as therapists, behaviour analysts, and educators can also be helpful in developing effective strategies to manage meltdowns and support individuals with ASD in their daily lives.

There are four dimensions to the AI-TOP pedagogical framework taken originally from Minocha (2009): educational, social, organisational and technological. For ease of use, the dimensions are presented as being independent of each other, whereas, in practice there are clear relationships between them. For example, the technical dimension includes a directive that that the device and computers available for use have built in cameras and microphones. Obviously for this to be in place, the organisation needs to check whether sufficient technical support is in place first and rectify it if there are shortcomings.

These dimensions have been successfully considered and applied by members of the consortium in previous Erasmus projects such as the ViPi KA3 LLL project (511792-LLP-1-2010-1-GR-KA3-KA3NW) (Standen & Burton, 2013[6]) and Edurob (543577-LLP-1-2013-1-UK-KA3-KA3MP) (Standen et al, 2016[7]). We draw on our experiences from those projects as well as the data from interviews undertaken in O1 and experience gained through data collection and piloting as the project was implemented.

2.5 The Four Dimensions

2.5.1 Educational:

This dimension encompasses the factors that are most directly concerned with the individual's learning. In tailoring the AI-TOP tools to each trainee, this dimension prompts trainers to answer the following questions and provides directives informed either by existing research or by partners' observations during piloting:

1.   How would the user benefit from the AI-TOP engagement or emotional dysregulation prediction software?

2.   Is there a particular feature that you would be more interested in for the user (e.g. their engagement level, or prediction of emotional dysregulation?)

3.   What interventions will I use if the system detects an event?

      a.   Dis-engagement

      b.   Onset of emotional dysregulation

Planning these interventions is crucial as the teacher must be able to act quickly, particularly for the latter, if the movement towards dysregulation is to be reversed. For each student you are likely to have strategies

---

[6] Standen, P & Burton A (2013); ViPi Educational and Pedagogical Framework available from https://isrg.org.uk/wp-content/uploads/2023/05/ViPi_Pedagogical_framework.pdf downloaded at 23/05/2023

[7] Standen, P; Hughes-Roberts, T; Burton, A; EduRob Educational and Pedagogic Framework available from https://www.edurob.eu/assets/EdurobPedagogicFramework.pdf at 23/05/2023

AI-TOP - 2020-1-UK01-KA201-079167

Co-funded by the
Erasmus+ Programme
of the European Union

you have used successfully in the past, but you could look at the list provided in the Handbook (See AI-TOP Output 4) further ideas. In terms of increasing engagement, different teaching strategies may need to be employed, e.g., changing the way the material is presented, gamifying the content, taking a break etc. We also provide a comprehensive list of ideas for this in the handbook.

4.   Would the use of the AI-TOP equipment setup detract from their engagement with the class? Is the student easily distracted by having a PC in from of them? Could you keep the machine away from them and just have a wired or better still, wireless USB camera in front of them?

Personalising learning experiences and predicting and diffusing meltdown moments in students with autism requires a tailored approach that takes into consideration their unique needs and characteristics. Here are some strategies that can be helpful:

Individualised Education Plans (IEPs): IEPs are legal documents that outline the educational goals, accommodations, and modifications for students with autism. Collaboration within a team of educators, special education professionals, and parents can be used to create an IEP that addresses the specific learning needs of the student. This may include customised academic goals, sensory supports, communication strategies, and behavioural interventions. These are known in the UK as EHCP (Education, Health & Care Plan).

Differentiated Instruction: Modification of teaching strategies and materials to match the individual learning style and abilities of the student with autism. This may involve using visual supports, providing hands-on learning opportunities, incorporating special interests, and using structured schedules and routines.

Social Skills Training: Provision of explicit instruction and practice in social skills to help students with autism develop appropriate social behaviours and interactions. This may include teaching skills such as greetings, turn-taking, sharing, and problem-solving through social stories, role-playing, and real-life situations.

Sensory Supports: Creation of a sensory-friendly learning environment by understanding and addressing sensory sensitivities and preferences of students with autism. This may involve providing sensory breaks, using sensory tools such as fidget toys or weighted blankets, and minimising sensory distractions in the classroom.

Emotional Regulation Strategies: Helping students with autism to develop strategies for managing their emotions and avoiding meltdown moments. This may include teaching self-regulation techniques such as deep breathing, mindfulness, and using visual supports to communicate emotions and express needs.

Data Collection and Analysis: Collection and analysis of data on the student's behaviours, academic progress, and emotional regulation can help to identify patterns and triggers for meltdown moments. This can help in predicting potential meltdown situations and implementing proactive interventions to diffuse them.

Collaborative Approach: Fostering open communication and collaboration among parents, educators, and other professionals involved in the student's education is important. Regularly reviewing and updating strategies and interventions based on the student's progress and feedback from all stakeholders results in the best outcomes.

Remember that every student with autism is unique, and what works for one student may not work for another. It is important to regularly assess and modify strategies based on the individual needs and progress

of each student. Consultation with qualified professionals, such as special education teachers, behaviour analysts, and occupational therapists, is recommended for additional support and guidance in personalising learning experiences and predicting and diffusing meltdown moments in students with autism.

> ➢ **How would students with autism benefit from personalised learning approaches?**

Students with autism can benefit greatly from personalised learning approaches in several ways:

Tailored Instruction: Personalised learning allows for instruction that is specifically tailored to the unique strengths, interests, and needs of students with autism. This can help them engage in the learning process more effectively and make meaningful progress towards their individualised goals.

Individualised Pace: Students with autism may have varying abilities and readiness levels across different academic areas. Personalised learning allows for flexibility in pacing, allowing students to progress at their own speed in each subject, which can prevent frustration and promote a positive learning experience.

Customised Content: Personalised learning approaches can provide students with autism with content that is relevant and meaningful to their interests and experiences. This can increase their motivation, engagement, and retention of information, as well as facilitate generalisation of skills to real-life situations.

Differentiated Instruction: Personalised learning can accommodate different learning styles and preferences of students with autism, such as visual supports, auditory cues, or hands-on activities. This can enhance their understanding and retention of information, and improve their overall learning outcomes.

Increased Independence: Personalised learning can empower students with autism to take ownership of their learning process and develop self-regulation skills. They can learn to set their own goals, track their progress, and make choices in their learning path, which can foster independence and self-advocacy skills.

Reduced Anxiety and Meltdowns: By providing individualised support, personalised learning approaches can help reduce anxiety and prevent meltdown moments in students with autism. When students feel understood and supported, and when their unique needs are met, they are more likely to be calm, engaged, and successful in their learning.

Improved Social Skills: Personalised learning can also incorporate social skills training and opportunities for social interactions, which are often areas of challenge for students with autism. By addressing social skills within the context of their learning experiences, personalised learning can help students with autism develop and practice social skills in a meaningful and relevant manner.

Overall, personalised learning approaches can greatly benefit students with autism by providing tailored instruction, accommodating their unique needs and preferences, promoting independence, reducing anxiety, and supporting their social and emotional development.

2.5.2 Social:

This dimension incorporates issues related to collaboration and group working. Use of the system relies upon the student being in-front of the camera, but this could mean a limitation in group learning flexibility. A balance should be found to enable the user to continue to engage with social learning tasks. Be aware that when the student is away from their camera, the system will cease to track their emotional states.

1. Would the use of the AI-TOP software with some members of the class benefit other members of the class?

2. Can peers help to increase engagement with learning materials?

3. Does working with peers initiate emotional dysregulation?

Finding the right balance between group work and individualised learning for students with ASD is important to ensure their social and academic development while addressing their unique challenges. Here are some strategies that can help strike a balance:

Structured Group Work: Implementing structured group work activities that provide clear guidelines and expectations, along with visual supports and social stories to help students with ASD understand the rules and routines of working in a group. Use visual schedules, visual cues, and social scripts to support their understanding and participation in group activities.

Social Skills Training: Prioritising social skills training within the curriculum to explicitly teach and practice the social skills necessary for successful group work, such as turn-taking, listening, sharing, and collaborative problem-solving. Visual supports, role-playing, and real-life scenarios can be used to facilitate social skills development.

Gradual Exposure: Starting with small group activities and gradually increasing the complexity and duration of group work as students with ASD gain confidence and develop social skills can be helpful. Providing additional support, such as a peer mentor or a social skills coach, can facilitate social interactions and help students with ASD feel more comfortable in a group setting.

Flexibility in Group Composition: It is good to recognise that not all students with ASD may feel comfortable working in groups, and to provide flexibility in group composition. Allowing students to choose their own group members can help, or provision of opportunities for both individual and group work to accommodate their preferences and comfort levels.

Individualised Accommodations: You should provide individualised accommodations to students with ASD in group work settings, such as visual supports, sensory breaks, or additional time, to help them manage sensory sensitivities, anxiety, or other challenges related to ASD.

Respect for Individual Differences: There is a need to recognise and respect the individual differences of students with ASD, and avoid forcing them into group work if it causes undue stress or anxiety. Allowing for

alternative forms of collaboration, such as online forums, virtual group activities, or paired activities with a familiar partner, can provide meaningful social interactions while addressing their specific needs.

Communication and Collaboration with Peers: Encouragement and facilitation of communication and collaboration among peers in group work settings can be achieved by providing structured opportunities for students with ASD to share their perspectives, ideas, and contributions, and by promoting a culture of inclusivity, respect, and acceptance among all students.

Striking the right balance between group work and individualised learning for students with ASD requires careful consideration of their unique needs, preferences, and challenges. Collaboration between special education professionals, parents, and the students themselves can help to develop strategies that promote social interaction, while also addressing the specific issues that students with ASD may face in group work situations. Flexibility, individualisation, and a supportive, inclusive environment can help students with ASD successfully navigate group work settings while maximising their social and academic growth.

> **How can social skills training be incorporated into the curriculum for students with ASD to support successful group work?**

Here are some specific examples of how social skills training can be incorporated into the curriculum for students with ASD to support successful group work:

Turn-taking: You can teach and practise turn-taking skills through activities such as games, discussions, or role-playing scenarios where students take turns to speak, share ideas, or participate in group discussions. Visual supports, such as visual schedules or cue cards, can also be used to help students understand and follow turn-taking rules.

Listening: You can incorporate listening skills training by providing explicit instruction on active listening techniques, such as making eye contact, facing the speaker, and summarising or paraphrasing what was said. Use activities that require students to actively listen to their peers, such as group discussions, partner activities, or presentations, and provide feedback on their listening skills.

Sharing: You can teach and reinforce sharing skills through activities that require students to share materials, ideas, or responsibilities within a group. For example, students can work together to complete a group project, share materials or resources during a science experiment, or take turns using a computer or other tools.

Collaborative problem-solving: You can provide opportunities for students to engage in collaborative problem-solving activities, where they work together to identify and solve problems as a team. This can include activities such as group brainstorming, group decision-making, or group projects that require students to work together to achieve a common goal.

Visual supports: Use of visual supports, such as visual schedules, social stories, or social scripts, can help students with ASD understand the expectations and steps involved in successful group work. Visual

supports can provide visual cues and reminders of social skills, facilitate communication, and support students in navigating social situations.

Role-playing: Role-playing activities can be used to practice social skills in a safe and structured environment. Students can take on different roles and practise social skills, such as turn-taking, listening, and problem-solving, through role-play scenarios that mimic real-life group situations.

Real-life scenarios: Opportunities should be provided for students to apply social skills in real-life scenarios. For example, students can engage in community-based learning experiences, such as field trips or community service projects, where they can practice social skills in authentic social situations outside the classroom.

It's important to note that social skills training should be individualised to meet the specific needs and abilities of each student with ASD. It may be necessary to use a combination of strategies, techniques, and supports to effectively teach and practise the social skills necessary for successful group work. Regular assessment and monitoring of social skills progress can also inform ongoing adjustments and modifications to the curriculum to ensure continued growth and development in social skills for students with ASD.

2.5.3   Organisational:

This dimension refers to the way in which the schools deal with the introduction and use of AI-driven technology.

Organisational factors can often be the biggest barrier to implementation, therefore the directive associated with this dimension is that:

The school must be supportive of the introduction of AI-TOP tools and resources, and possess an appropriate pedagogic culture. Before engaging with AI-TOP it is important to determine where the approach fits in with current practices. It is also important to ensure that schools, parents and their supporting trusts are happy to adopt the approach. Permissions may need to be sought for the use of cameras even though they are processing in real time and not saving any video or audio streams.

For many trainers, dealing with these aspects may be outside their remit but three questions that might be useful for them to answer are:

1. Is there sufficient support for the initiative inside the organisation?

2. Do the trainers themselves feel confident using the AI-TOP tools?

3. How will using AI-TOP tools fit in with the classroom environment? Does it need to be augmented or altered in any way?

The introduction and use of AI-driven technology in schools can be a valuable tool to enhance learning experiences and support students with diverse needs, including those with ASD. Here are some best practices for schools to consider when dealing with the introduction and use of AI-driven technology:

Clear Goals and Objectives: Clear goals and objectives should be set out for the use of AI-driven technology in the school setting. The intended outcomes and expectations for the use of AI technology should be defined, and aligned with the overall educational goals and priorities of the school.

Needs Assessment: A thorough needs assessment should be conducted to identify the specific needs of students, teachers, and the school community that can be addressed through AI-driven technology. Factors such as student learning needs, teacher capabilities, infrastructure requirements, and budget considerations should all be considered to inform the selection and implementation of AI-driven technology.

Inclusive Approach: You should ensure that the use of AI-driven technology is inclusive and addresses the diverse needs of all students, including those with special needs such as ASD. Accessibility features, customisation options, and individualised learning pathways should be considered to accommodate students with different learning styles and abilities.

Professional Development: Comprehensive professional development and training for teachers, staff, and other stakeholders on the use of AI-driven technology should be provided. This should include training on the technical aspects of the technology, pedagogical strategies for integrating AI technology into instruction, and considerations for supporting students with diverse needs.

Ethical Use and Data Privacy: Ethical guidelines and best practices for the use of AI-driven technology in schools, including data privacy and security should be followed. Ensuring that student data is protected and used in compliance with relevant laws and regulations is essential, and ethical considerations, such as bias and fairness, should be addressed in the use of AI-driven technology.

Piloting and Evaluation: Small-scale pilots and evaluations of AI-driven technology should be trialled before widespread implementation takes place. Gathering feedback from teachers, students, and other stakeholders can help to assess the effectiveness of the technology in achieving the intended goals and objectives, and allow any adjustments as required.

Parent and Community Engagement: We should involve parents and the wider school community in the introduction and use of AI-driven technology. Opportunities should be provided for parents to understand and input on the use of AI technology, addressing any concerns or questions they may have.

Ongoing Monitoring and Support: Provision of ongoing monitoring and support for the use of AI-driven technology in schools is crucial. This includes regular review and assessment of the technology's effectiveness, troubleshooting and technical support, and continuous professional development for teachers and staff.

Collaboration and Partnerships: You should collaborate with experts, researchers, and other stakeholders in the field of AI and education to stay updated on the latest research, best practices, and innovations in the use of AI technology in schools. You can explore partnerships with AI technology providers, educational institutions, and other relevant organisations to leverage their expertise and resources.

Flexibility and Adaptability: We should be flexible and adaptable in the use of AI-driven technology, as the field is rapidly evolving. Staying informed about emerging technologies, research, and best practices, and being willing to adjust and adapt the use of AI technology to meet the changing needs of students and the school community will provide the best outcomes.

By following these best practices, schools can effectively introduce and use AI-driven technology in an inclusive and impactful manner, benefiting all students, including those with ASD, and enhancing the overall educational experience.

> **What practices could help to involve parents and the wider school community in the use of AI technology?**

Involving parents and the wider school community in the introduction and use of AI-driven technology could be applied through various strategies and approaches. Here are some examples:

Parent Information Sessions: Schools could organise information sessions or workshops specifically focused on AI-driven technology and its use in education, targeting parents of students with ASD. These sessions could provide an overview of the technology being used, its potential benefits, and how it may be integrated into the educational program. Parents can have the opportunity to ask questions, seek clarifications, and voice any concerns they may have.

Parent Education Resources: Schools could develop and distribute educational resources such as brochures, pamphlets, or handouts that explain the purpose, benefits, and safeguards associated with the use of AI-driven technology in education. These resources could be provided to parents in written or digital formats, and made available in multiple languages to ensure accessibility for all parents.

Collaborative Planning and Decision Making: Schools could involve parents in the planning and decision-making process related to the introduction and use of AI-driven technology. This may include forming committees or task forces that include parent representatives to provide input, feedback, and recommendations on the selection, implementation, and evaluation of AI-driven tools and services. Parents could also be involved in discussions on issues such as privacy, data security, and ethical considerations related to the use of AI technology.

Open Communication Channels: Schools could establish open communication channels with parents to facilitate ongoing dialogue about the use of AI-driven technology. This may include regular newsletters, email updates, or dedicated communication platforms where parents ask questions, provide feedback, and

express concerns related to the use of AI technology. Schools should ensure that there are designated staff members who are available and responsive to address any enquiries or concerns from parents.

Parent Training and Support: Schools could provide training and support to parents on how to effectively use and support their child's learning with AI-driven technology. This might include workshops or webinars on how to navigate the specific tools or platforms being used, how to monitor their child's progress, and how to reinforce learning at home. Providing parents with the necessary skills and knowledge to support their child's use of AI-driven technology could foster a collaborative partnership between home and school.

Regular Review and Feedback: Schools could regularly review and gather feedback from parents on the use of AI-driven technology. This might be done through surveys, focus groups, or feedback forms to assess the effectiveness of the technology in meeting the educational needs of students with ASD, addressing any concerns or suggestions from parents. This feedback would inform ongoing improvements and adjustments to the use of AI technology in the educational program.

By involving parents and the wider school community in the introduction and use of AI-driven technology, schools could ensure that parents are informed, engaged, and supportive of the technology being used for students with ASD. This collaborative approach would help address concerns, build trust, and could create a positive environment for the effective integration of AI-driven technology in the educational program.

2.5.4 Technological:

This dimension includes factors related to access, implementation and maintenance of the tools and services. For AI-TOP to be able to run and be available for the learners who need it, there are important directives that need to be followed:

1. The organisation must have hardware and operating systems that support the AI-TOP software (e.g. Windows 10 +, webcam present). Does the organisation have enough suitable PCs for the system to be adopted. Is there sufficient technical support within the organisation/school to enable use of the AI-TOP system?

2. Access to administrator privileges is required to install the software – or the IS provider will be required to set up the software on the classroom PCs.

3. Permissions must be set to allow the PC software to contact the mobile app.

4. The teacher must have access to a mobile device capable of installing the app and therefore receiving the traffic light codes sent by the system. Battery life and charging of this device should also be considered.

   a. Who would carry/wear the receiving device?

When implementing AI-driven tools and services in schools with students with ASD there are several factors related to access, accessibility, implementation, and maintenance that need to be considered. These factors include:

Infrastructure and Technology Access: Schools need to ensure that they have the necessary infrastructure and technology access to support the implementation of AI-driven tools and services. This may include having reliable internet connectivity, appropriate hardware and devices, and adequate technical support to ensure smooth functioning of the AI technology.

Accessibility Features: Where AI-driven tools and services need to be accessed by students with ASD, they should be designed with accessibility features in mind to ensure access to the technology as required. This may include features such as adjustable font sizes, colour contrast options, text-to-speech capabilities, and alternative input methods to accommodate different sensory and motor needs.

Customisation and Individualisation: AI-driven tools and services should allow for customisation and individualisation to meet the diverse needs of students with ASD. This may include options to personalise learning pathways, adapt content and difficulty levels, and provide feedback in a format that is most effective for individual students.

Training and Professional Development: Teachers and staff need to receive adequate training and professional development to effectively implement and use AI-driven tools and services with students with ASD. This may include training on the technical aspects of the technology, understanding the needs of students with ASD, and strategies for integrating AI technology into instruction in a way that supports their learning and development.

Collaboration and Coordination: Collaboration and coordination among teachers, staff, and other stakeholders is crucial for successful implementation of AI-driven tools and services in schools with students with ASD. This may involve regular communication, coordination of efforts, and sharing of best practices to ensure that the technology is being used effectively to support the unique needs of students with ASD.

Data Privacy and Security: Schools need to ensure that the use of AI-driven tools and services complies with relevant data privacy and security regulations. This includes protecting student data, ensuring that data is collected, stored, and used securely, and obtaining appropriate consent from parents or guardians.

Ongoing Maintenance and Support: AI-driven tools and services require ongoing maintenance and support to ensure their effective use over time. This may involve regular updates, troubleshooting, and technical support to address any issues that may arise.

Evaluation and Assessment: Schools should conduct ongoing evaluation and assessment of the effectiveness of AI-driven tools and services in supporting the learning and development of students with ASD. This may involve collecting data, analysing outcomes, and making adjustments as needed to optimise the impact of the technology on student outcomes.

Parent and Community Engagement: Involving parents and the wider school community in the implementation of AI-driven tools and services is important. This may involve providing information,

seeking feedback, and addressing any concerns or questions that parents or other community members may have to ensure a collaborative and supportive approach.

By carefully considering and addressing these factors, schools can effectively implement and maintain AI-driven tools and services for students with ASD, ensuring access, effective use, and positive impact on their learning and development.

➢ **How can AI-driven tools and services be tailored to personalise learning pathways, adapt content and difficulty levels, and provide feedback in a format that is most effective for individual students with** ASD**?**

When it comes to personalising learning pathways, adapting content and difficulty levels, and providing feedback in a format that is most effective for individual students with ASD, there are several examples of how AI-driven tools and services can be tailored to meet their unique needs. Here are some examples:

Personalised Learning Pathways: AI-driven tools can analyse a student's learning preferences, strengths, and areas for improvement to create a customised learning pathway. For example, an AI-powered learning platform may assess a student's skills and knowledge through assessments or interactions, and then dynamically generate a personalised learning plan that includes specific learning goals, activities, and resources tailored to their needs. This allows students with ASD to learn at their own pace, focus on their areas of interest, and receive targeted support in areas where they may struggle.

Adapted Content and Difficulty Levels: AI-driven tools can adapt the content and difficulty levels of learning materials to match the individual learning needs of students with ASD. For example, an AI-powered educational game may dynamically adjust the difficulty level based on the student's performance, providing more challenging tasks for students who are advanced and more scaffolding for students who are struggling. This ensures that the content is appropriately challenging without overwhelming or frustrating the student, and allows for a more individualised learning experience.

Feedback in Preferred Format: Students with ASD may have unique sensory or cognitive preferences when it comes to receiving feedback. AI-driven tools can provide feedback in a format that is most effective for individual students. For example, some students with ASD may prefer visual feedback in the form of charts, graphs, or visual cues, while others may prefer auditory feedback in the form of spoken instructions or audio prompts. AI-powered tools can adapt the format of feedback based on the student's preferences, making it more meaningful and effective for their learning style.

Customised Instructional Supports: AI-driven tools can provide customised instructional supports that are tailored to the needs of students with ASD. For example, an AI-powered virtual tutor may use natural language processing capabilities to engage in interactive conversations with students, providing step-by-step guidance, modelling, and prompting to support their understanding and learning. This allows for individualised instruction and support that is responsive to the specific needs and abilities of students with ASD.

Social Skills Training: AI-driven tools can also be used to provide social skills training for students with ASD who may experience challenges with social interaction. For example, an AI-powered social skills training program may use virtual avatars or characters to simulate social situations, providing opportunities for students with ASD to practice and develop social skills in a controlled and supportive environment. The AI can provide real-time feedback and guidance, helping students improve their social skills and build confidence in their social interactions.

These are just a few examples of how AI-driven tools and services can be personalised to meet the unique learning needs of students with ASD. The key is to leverage the capabilities of AI technology to provide individualised, adaptable, and effective support that is responsive to the specific strengths and challenges of students with ASD, whilst also considering their sensory, cognitive, and social preferences for an optimal learning experience.

2.6 Summary Overview: A framework to guide Teachers, TAs and SENCOs in how to increase the engagement of, and avoid meltdowns in, students with ASD.

2.6.1 NEEDS ANALYSIS

The role of the Pedagogical Framework is to provide Teachers, SENCOs, TAs and Parents & Carers with a 'blueprint' on how to optimally adopt and use the project's App and related
resources. The framework is based on research in earlier EU projects introducing novel technologies into special educational classrooms (e.g., see - Standen et al, 2009. Virtual Portal
for Interaction and ICT Training for People with Disabilities. Available at http://www.vipi-project.eu/wp-content/uploads/2014/02/D18-ViPi-Blended-Educational-Pedagogicalframework2.
pdf).

Four dimensions are being considered in our Pedagogical Framework taken from Minocha (A Study on the Effective Use of Social Software by Further and Higher Education in
the UK to Support Student Learning and Engagement, 2009[8]. These dimensions are Educational, Social, Organisational and Technical.
While for ease of use, the dimensions will be presented as being independent of each other, in practice there are clear relationships between them.

1. Educational: This dimension encompasses the factors that are most directly concerned with the individual's learning. In tailoring our use of AI to personalise learning experiences,

---

[8] • Minocha S (2009) A Study on the Effective Use of Social Software by Further and Higher Education in the UK to Support Student Learning and Engagement (Final Report); JISC Learning and Teaching Committee; The E-learning Programme; The Open University UK;
https://www.webarchive.org.uk/wayback/archive/20140613220103/http://www.jisc.ac.uk/media/documents/projects/effective-use-of-social-software-in-education-finalreport.pdf downloaded at 23/05/2023;

and predicting and diffusing meltdown moments in students with autism. This dimension prompts school staff to answer a range of indicative questions and provides directives to guide schools in how to best adopt this novel intervention.

Example Question: How would students with autism benefit from personalised learning approaches? Possible benefits might include that pupils with autism are supported to make best academic progress possible.

2. Social: This dimension incorporates issues related to collaboration and group working. Many young people with disabilities can already be experiencing too much social isolation.

However, students on the autism spectrum may have difficulty working in a group, related to some of the characteristics of ASD. Using computers to personalise the learningexperience has the potential to further reduce opportunities for group work. Thus, the right balance must be found between different strands of group work, whilst adopting strategies

that recognise some of the issues students with ASD have in working with a partner, or in groups.

3. Organisational: This dimension refers to the way in which the schools deal with the introduction and use of AI-driven technology. Organisational factors can often be the biggestbarrier to implementation therefore the directive associated with this dimension is that adopting schools should be supportive of the introduction of AI driven technology, and possess an appropriate pedagogic culture.

4. Technological: This dimension includes factors related to access, accessibility, implementation and maintenance of the AI-driven tools and services. Schools must have appropriate hardware and sensors to use this innovative AI-driven technology.

2.6.2   TARGET GROUPS

- Teachers, teaching assistants, and special educational needs coordinators (SENCOs) in mainstream education, inclusive settings, and special educational settings.
- Beneficiaries: students with ASC, and their families.
- Stakeholders: policy makers, pedagogical experts, schools, school authorities and their umbrella structures all over Europe. Service providers supporting students with ASD; Localeducation authorities at all levels, Associations for teachers and teacher unions.

2.6.3   ELEMENTS OF INNOVATION

Our project offers a complete "toolkit" of solutions to assist teachers, teaching assistants and SENCOs in special and inclusive education, to make well-informed decisions with regards to the pedagogical approaches that will be most effective and/or efficient for their students with ASC, to promote engagement and hence the effectiveness of their learning approaches. It also extends its support beyond the school boundaries, and offer parents and carers a tool that can help predict and diffuse 'meltdown' events.

2.6.4   EXPECTED IMPACT

This Framework will help schools to plan and implement AI-driven technology for use with students with ASC to provide personalisation in learning, with fewer incidents of challenging behaviour, and decreased instances of absenteeism and bullying. These innovations will result in improved understanding of autism both within school, and in the wider community.

2.6.5 TRANSFERABILITY POTENTIAL

This Framework for the adoption of AI-Driven technology is transferable to other groups of school students also at risk of exclusion, including those with ADHD, and the general school population of mainstream students.

3 Example Personae with suggested interventions

We have created a set of six personae which are presented below. Each one represents a typical subgroup of children with ASD, and presents a number of diagnoses, symptoms, ages and school types. Each presents the benefits gained by using AI-TOP outputs over not using them, and also offers a range of potential mitigation measures to try. It is hoped that by identifying a similar persona to a child in their class, a teacher will be able to use this advice by matching a persona to an individual in their class.

> **Gender:** male
>
> **Age:** 11
>
> **Diagnosis:** ASD
>
> **Symptoms:** heightened sensitivity to sensory stimuli, such as loud noises, bright lights, or certain textures; fidgeting and repetitive movements to regulate sensory input; struggles with transitioning between activities or topics, finding sudden changes in routine overwhelming and challenging to adapt to; experiences difficulties with social communication and interaction; understanding social cues and engaging in conversations with peers can be challenging for him; organizing tasks, planning, and staying focused is challenging; increased vulnerability to stress and frustration
>
> **School:** Attends regular primary school; support teacher on weekly basis

A typical persona of an 11-year-old boy with autism who struggles with concentration in the classroom may exhibit the following characteristics:

- Sensory sensitivity: The boy has heightened sensitivity to sensory stimuli such as loud noises, bright lights, or certain textures. These sensory sensitivities can distract him and make it difficult to focus on the lesson.
- Difficulty with transitions: The boy struggles with transitioning between activities or topics. Sudden changes in routine can be overwhelming for him, leading to a loss of concentration.
- Restricted interests: He has intense and specific interests, often focusing on a particular subject or object. When the classroom material does not align with his interests, it can be challenging for him to engage and maintain attention.
- Difficulty with social interaction: He has challenges with social communication and interaction, which can further impact his ability to concentrate. He sometimes struggles to understand social cues or have difficulty engaging in conversations with peers.

WITHOUT AI-TOP

When the boy is experiencing difficulties concentrating in the classroom, it may lead to a "rumble effect" that can escalate into an actual meltdown. The rumble effect refers to a gradual build-up of stress or frustration that eventually reaches a breaking point. This can manifest in various ways, such as increased fidgeting, repetitive behaviours, increased restlessness, or emotional distress.

If the rumble effect escalates into a meltdown, the boy may experience an intense emotional and behavioural reaction. This can include crying, screaming, aggression, self-injurious behaviour, or attempts to escape the situation. It is important to note that meltdowns are not intentional misbehaviour but rather a result of overwhelming sensory or emotional overload.

WITH AI-TOP

The development of our innovative app that can infer the level of engagement of students with autism and predict "meltdown" moments could have a significant impact on the boy described earlier. Here's how it could positively affect the boy:

- Early intervention: With the app's ability to predict "meltdown" moments, teachers and caregivers can intervene at the "rumble" stage, which is crucial for preventing the escalation of challenging behaviours. By recognising the signs of distress or decreased engagement early on, appropriate strategies can be implemented to support the student before a full-blown meltdown occurs.
- Engagement and personalised support: The app's ability to infer the level of engagement of students with autism can provide valuable insights into their individual needs and preferences. This information can help tailor the learning experiences to match their interests and strengths, promoting better engagement and concentration in the classroom. The boy may benefit from the app's ability to identify specific areas of interest and incorporate them into the lessons, thus enhancing the student's overall learning experience. The app's data collection and analysis capabilities can provide valuable information for teachers, parents, and specialists involved in supporting the student's education. By tracking the student's engagement patterns and identifying triggers for decreased concentration, they can gain insights into the specific factors that impact the student's learning experience. This information can inform the development of targeted interventions and accommodations to support the student's learning and prevent future challenges.

Also:

- Collaboration and communication: The app can facilitate better collaboration and communication among teachers, parents, and other professionals involved in supporting the student. By sharing real-time data and insights through the app, all stakeholders can stay informed about the student's engagement levels and potential challenges. This enables a more coordinated and proactive approach to support the student's needs, ensuring consistency across different environments and promoting continuity of care.
- Empowerment and awareness: The app can also contribute to increasing awareness and understanding of autism within the educational community. By providing real-time insights and predictive capabilities, it can help teachers and peers recognise and respond to the unique needs

and challenges faced by students with autism. This can foster a more inclusive and supportive classroom environment for the boy and other students with similar needs.

WHAT IF A MELTDOWN DOES OCCUR

When a meltdown occurs nevertheless during a lesson, it is crucial for his teachers to respond with empathy and understanding. Here are some strategies for the teacher that can be helpful:

- Create a safe space: Ensure that there is a designated safe space in the classroom where the boy can retreat to when he needs a break. This space should be quiet, calming, and equipped with sensory tools or objects that may help him regulate his emotions.
- Provide predictability and structure: Establish a consistent daily routine and use visual schedules or timers to help the boy understand and anticipate transitions between activities. Clearly communicate any changes in advance and provide visual or verbal cues to guide him through the transition.
- Implement individualised accommodations: Work closely with the boy's parents and any specialists involved to develop an individualised education plan or behaviour plan. This plan should outline specific strategies and accommodations to support his learning and address his unique needs.
- Use visual supports: Incorporate visual aids such as visual schedules, visual cues, or social stories to enhance his understanding of classroom expectations and to provide additional structure and support.
- Offer sensory breaks: Allow the boy to take short breaks when he is feeling overwhelmed. These breaks can involve sensory activities or exercises that help him self-regulate, such as deep breathing, using a stress ball, or engaging in a preferred calming activity.
- Practice a sensory-friendly environment: Create a sensory-friendly classroom environment by minimising unnecessary sensory stimuli. Consider reducing fluorescent lighting, using ear defenders or white noise machines to manage auditory distractions, and providing alternative seating options if necessary.
- Foster peer understanding and support: Educate the other students in the class about autism and encourage empathy and inclusion. This can help create a supportive classroom environment where classmates understand and accept the boy's differences.

Co-funded by the
Erasmus+ Programme
of the European Union

Gender: female

Age: 13

Diagnosis: ASD + Tourette Syndrome

Symptoms: heightened sensitivity to sensory stimuli, which can be further exacerbated during tic episodes; sensory triggers may intensify her tics and impact her ability to concentrate; involuntary motor and vocal tics as a result of Tourette Syndrome; faces difficulties in social communication and interaction due to her autism; engages in sensory-seeking or sensory-avoidant behaviours to regulate her sensory input during tic episodes; struggles with executive functioning skills such as organisation, planning, and attention; experience difficulties in emotional regulation, particularly during tic overload

School: Attends regular primary school; support teacher on daily basis

Personal note: "When I have a tic overload and face the effects of both Tourette Syndrome and ASD, it can be overwhelming and challenging for me. The tics, whether vocal or movement-based, feel like an uncontrollable force taking over my body. It's like having an itch that I can't scratch or a sneeze that I can't release. Each tic brings with it a mix of physical discomfort and a sense of frustration. During these moments, my mind feels scattered, making it difficult to concentrate on anything else. It's as if my thoughts are bouncing around like ping pong balls, and I struggle to keep them organised. This can be especially frustrating when I'm trying to focus on the teacher's instructions or participate in classroom activities. The tics themselves draw attention, and I can't help but notice the stares and whispers from my peers. Sometimes, their lack of understanding can make me feel isolated and different. It's hard for them to understand that these tics are not intentional or within my control. I wish they could see beyond the tics and recognise that I have so much more to offer as a person. In addition to the tics, the challenges of ASD add another layer of complexity. Social interactions can be confusing and overwhelming. It's hard for me to pick up on social cues and understand the unwritten rules of conversation. This can make it difficult to connect with my peers and feel like I truly belong. In moments like these, I long for understanding and support. I wish others could see the effort I put into managing my tics and navigating the world with ASD. It would mean the world to me if my teachers and classmates could create a safe and accepting environment where I feel comfortable being myself, tics and all. I am more than my tics and my ASD. I have dreams, interests, and passions that go beyond the challenges I face. With the right support and understanding, I believe I can overcome these obstacles and thrive in the classroom. I hope for a future where I am seen for who I truly am, beyond the surface-level tics and ASD, and where my potential is recognised and celebrated."

WITHOUT AI-TOP

Her teachers had a limited understanding of the specific triggers, patterns, and signs of engagement or distress for her as a student with autism and Tourette Syndrome. Teachers often had a reactive approach to managing the student's tics and ASD-related challenges, addressing them only after they became disruptive or escalated. While they were rare, teachers did struggle to pre-empt meltdowns and subsequently manage the "rumble" stage effectively. This then resulted in increased challenges and disruption in the classroom. Peers had limited awareness and understanding of the student's conditions,

leading to social isolation or misunderstandings. Equally, neither did the teachers. The classroom environment was not proactively designed to accommodate the student's sensory needs and promote a supportive and inclusive atmosphere.

WITH AI-TOP

Using the app, teachers obtained a deeper understanding of the student's triggers, engagement patterns, and signs of distress, enabling them to respond proactively and effectively, thus managing the student's tics and ASD-related challenges, leveraging the app's insights to pre-empt and mitigate difficulties. The app's predictive capabilities enabled teachers to identify "rumble" stages and potential meltdown moments, allowing for early intervention and support.

The app promoted active collaboration among teachers, parents, and specialists, facilitating the sharing of real-time data, strategies, and progress monitoring to ensure comprehensive support, while sharing experiences. As a result, the student started receiving consistent accommodations and understanding across different teachers and classroom environments, promoting a stable and supportive learning experience.

Because of the increased awareness, the classroom environment was proactively designed to accommodate the student's sensory needs, minimizing triggers, and optimising their focus and engagement.

WHAT IF A MELTDOWN DOES OCCUR

When the girl experiences a tic overload combined with ASD, the teacher should:

- Tourette related:
    - Remain calm and supportive: Stay calm and provide a supportive presence for the girl during tic episodes. Maintain a nonjudgmental and understanding attitude.
    - Respect privacy and dignity: Respect the girl's privacy and dignity by avoiding drawing unnecessary attention to her tics. Allow her to manage her tics discreetly, if desired.
    - Provide a safe space: Create a safe and accepting environment where the girl feels comfortable expressing her tics. Ensure that she has a designated space where she can take a break or engage in tic-management strategies when needed.
    - Offer accommodations: Implement individualised accommodations to support her during tic overload, such as flexible deadlines, modified assignments, or additional breaks. Adjust expectations accordingly while maintaining appropriate academic standards.
    - Encourage self-advocacy: Foster the development of self-advocacy skills in the girl, empowering her to communicate her needs and preferences regarding tics and related challenges. Teach her strategies for self-regulation and provide opportunities for her to practise advocating for herself.
- ASD related:
    - Use visual supports: Utilise visual supports, such as visual schedules, timers, or cue cards, to assist the girl in understanding and following classroom routines and transitions. Visual supports can help her stay organised and focused.

- o Educate peers: Educate the classmates about Tourette Syndrome and ASD to promote understanding and acceptance. Encourage open conversations about differences, fostering empathy and supportive relationships among peers.
- o Collaborate with specialists: Work closely with specialists, such as the girl's occupational therapist or speech therapist, to incorporate appropriate strategies and interventions into the classroom setting. Share observations and collaborate on implementing individualised support plans.
- o Communicate with parents: Maintain open lines of communication with the girl's parents or guardians. Share observations, discuss any concerns, and collaborate on strategies to support her both at school and home.
- o Seek professional guidance: If the girl's tic overload and ASD-related challenges significantly impact her educational experience, consult with specialists or professionals with expertise in Tourette Syndrome and autism for further guidance and support.

Gender: male

Age: 10

Diagnosis: ASD, non-verbal

Symptoms: Non-verbal, limited communication, sensory sensitivities, restricted interests, repetitive behaviours, challenges with social interaction, difficulty with transitions, meltdowns, communication barriers, limited peer interaction, executive functioning challenges.

School: Attends special education primary school

A typical persona of a 10-year-old boy with non-verbal autism who struggles with concentration in the classroom may exhibit the following characteristics:

- Non-verbal Communication: The boy has limited or no verbal communication skills, making it challenging for him to express his needs, thoughts, or emotions through speech.
- Augmentative and alternative Communication (AAC): He uses alternative means of communication, such as picture cards, sign language, or assistive technology devices, to express his wants and needs.
- Sensory sensitivities: The boy has heightened sensitivity to sensory stimuli, including sound, light, touch, or certain textures. Sensory overload leads to decreased attention and increased distress.
- Difficulty with transitions: He struggles with transitioning between activities or changes in routine, leading to increased anxiety and potential disruptions.
- Restricted and repetitive behaviours: The boy engages in repetitive movements and has specific routines that provide him with a sense of comfort and predictability.
- Challenges with social interaction: He has difficulties understanding and engaging in social interactions, such as making eye contact, taking turns, and understanding non-verbal cues.
- Limited flexibility and predictability: The boy requires a structured and predictable environment to feel secure. Unexpected changes trigger anxiety and contribute to the rumble effect.
- Rumble effect: The rumble effect occurs when the boy starts to experience increasing stress, anxiety, or sensory overload. This manifests as restlessness, increased agitation, fidgeting, and vocalisations.
- Meltdown: If the rumble effect is not effectively addressed, it can escalate into a meltdown. During a meltdown, the boy displays intense emotional and behavioural reactions, such as crying, screaming, self-injury, or attempting to flee the situation.

WITHOUT AI-TOP

Teachers have limited means of effective communication with the non-verbal boy, making it challenging to understand his needs, preferences, and level of engagement. It is difficult for teachers to accurately assess the boy's level of engagement in classroom activities due to his limited communication abilities. Teachers take a reactive approach to managing challenging behaviours or meltdowns, as they do not have sufficient tools or insights to pre-empt or address them effectively. Support for the non-verbal boy's individual needs and communication methods vary depending on the teacher's understanding and expertise in accommodating non-verbal students with autism. There may be a lack of data-driven insights

into the boy's engagement patterns, triggers, and individualised strategies that could optimize his learning experience. Communication between teachers, parents, and specialists is limited, hindering the sharing of information and collaborative efforts to support the boy's educational journey. Teachers have limited awareness of the boy's sensory sensitivities, restricted interests, and other characteristics that impact his engagement and well-being.

WITH AI-TOP

The development of our innovative app that can infer the level of engagement of students with autism and predicted "meltdown" moments could have a significant impact on the boy described earlier. Here's how it could positively affect the boy:

- Enhanced communication: The mobile app provides teachers with effective communication tools to better understand the non-verbal boy's needs, preferences, and engagement levels.
- Improved assessment of engagement: The app's features allow teachers to more accurately assess the boy's level of engagement in different classroom activities, helping them tailor instruction and interventions accordingly.
- Proactive intervention: The app's insights enable teachers to take a proactive approach in managing challenging behaviours or meltdowns, providing early intervention and support to prevent or minimise disruptions.
- Consistent support: The mobile app ensures consistent support for the non-verbal boy's individual needs and communication methods, regardless of the teacher's level of expertise or understanding.
- Data-driven insights: The app's data collection and analysis capabilities provide valuable insights into the boy's engagement patterns, triggers, and individualised strategies that optimize his learning experience.
- Improved collaboration: The app facilitates seamless communication and collaboration between teachers, parents, and specialists, enhancing the sharing of information and coordinated efforts to support the boy's educational journey.
- Comprehensive understanding: Teachers gain a more comprehensive understanding of the boy's sensory sensitivities, restricted interests, and other characteristics, enabling them to create a more inclusive and supportive classroom environment.
- Enhanced peer interaction: Peers have a better understanding of the non-verbal boy's communication methods and needs through the app's educational resources and shared insights, promoting empathy, acceptance, and meaningful interactions.
- Increased empowerment: The app empowers the non-verbal boy by providing opportunities for self-expression and self-advocacy, fostering his sense of agency, autonomy, and overall well-being.
- Optimised classroom environment: With the insights from the app, teachers can optimise the classroom environment to better support the non-verbal boy's specific needs, minimising challenges and enhancing his engagement and learning experience.

WHAT IF A MELTDOWN DOES OCCUR

When a meltdown occurs nevertheless during a lesson, it is crucial for his teachers to respond with empathy and understanding. Here are some strategies for the teacher that can be helpful:

- Provide a calm and safe environment: Create a calm and safe physical space within the classroom where the boy can retreat to when he needs a break or when the rumble effect occurs.
- Understand communication methods: Familiarise yourself with the boy's specific AAC system or non-verbal communication methods to effectively understand and respond to his needs and messages.
- Recognise early signs: Be attentive to early signs of distress or sensory overload. These signs can include increased restlessness, repetitive behaviours, or changes in body language. Intervene at the rumble stage to prevent a full meltdown.
- Reduce sensory overload: Modify the classroom environment to minimise sensory stimuli that may contribute to the rumble effect. This can include adjusting lighting, reducing noise, or providing sensory breaks with appropriate tools and materials.
- Offer predictability: Establish a structured and predictable routine, using visual schedules and cues to help the boy anticipate transitions and activities. Advance notice of changes can help minimise anxiety and the rumble effect.
- Use visual supports: Utilise visual supports, such as visual schedules, visual cues, or social stories, to enhance the boy's understanding of expectations and facilitate comprehension during lessons.
- Provide sensory regulation techniques: Teach and encourage the use of sensory regulation techniques that can help the boy self-regulate, such as deep breathing exercises, sensory tools, or preferred calming activities.
- Reinforce positive behaviour: Use positive reinforcement strategies to acknowledge and reward the boy's efforts and appropriate behaviours, promoting a positive learning environment.
- Collaborate with support staff: Work closely with support staff, such as speech-language therapists or occupational therapists, to develop and implement individualised strategies and accommodations tailored to the boy's specific needs.
- Communicate with parents: Maintain open communication with the boy's parents or caregivers, sharing observations, strategies, and progress. Collaborate with them to ensure consistency between the home and school environments.

AI-TOP - 2020-1-UK01-KA201-079167

Co-funded by the
Erasmus+ Programme
of the European Union

Gender: female

Age: 10

Diagnosis: ASD, ADHD

Symptoms:
Autism: Social communication challenges, restricted interests, sensory sensitivities, difficulty with transitions, executive functioning difficulties
ADHD: Hyperactivity, impulsivity, inattention
Overall: Communication barriers, emotional regulation challenges, rumble effect, meltdowns, reduced self-advocacy, peer interaction difficulties

School: Attends special education primary school

A typical persona of an 11-year-old girl with autism and ADHD who struggles with concentration in the classroom may exhibit the following characteristics:

- Autism characteristics: The girl experiences challenges with social communication and interaction, restricted interests, sensory sensitivities, and difficulty with transitions and executive functioning.
- ADHD characteristics: She exhibits symptoms of hyperactivity, impulsivity, and inattention. These manifest as restlessness, difficulty staying focused, and impulsiveness.
- Sensory sensitivities: The girl has heightened sensitivity to sensory stimuli, such as noise, light, or certain textures. Sensory overload can lead to decreased concentration and increased distress.
- Emotional regulation challenges: Difficulty regulating emotions contributes to the rumble effect. The girl experiences increased frustration, irritability, or anxiety, which can escalate into a meltdown.
- Hyperactivity and restlessness: Hyperactive and impulsive behaviours, such as fidgeting, difficulty sitting still, or constant movement, etc. making it challenging for her to remain focused in the classroom.
- Executive functioning difficulties: She struggles with executive functioning skills, including organisation, time management, and task completion. This leads to difficulties with following instructions, completing assignments, and staying on track.
- Rumble effect: The rumble effect occurs when the girl experiences increasing stress, frustration, or sensory overload. This will lead to restlessness, heightened emotional states, increased impulsivity, and decreased ability to focus.
- Meltdown: If the rumble effect is not addressed, it will escalate into a meltdown. A meltdown is characterised by intense emotional and behavioural reactions, such as crying, yelling, aggression, or attempts to flee the situation.

WITHOUT AI-TOP

Teachers have limited means of effective communication and understanding of the specific needs and challenges of the girl with autism and ADHD. This makes it difficult to address her individualised requirements. Teachers face difficulties in accurately assessing the girl's level of engagement due to her unique communication and attentional needs. Teachers adopt a reactive approach to managing

challenging behaviours or meltdowns, as they lack the tools or insights to anticipate or address them proactively. Support for the girl's individual needs and accommodations varies depending on the teacher's understanding and familiarity with autism and ADHD. There is a lack of data-driven insights into the girl's engagement patterns, triggers, and individualised strategies that could optimise her learning experience. Teachers have limited awareness of the girl's sensory sensitivities, executive functioning difficulties, and the interplay of her autism and ADHD symptoms.

WITH AI-TOP

The development of our innovative app that can infer the level of engagement of students with autism and predicted "meltdown" moments could have a significant impact on the boy described earlier. Here's how it could positively affect the girl:

- Enhanced communication and understanding: The mobile app provides teachers with effective means of communication and a better understanding of the girl's needs, challenges, and engagement levels.
- Improved assessment of engagement: The app's features enable teachers to more accurately assess the girl's level of engagement in different classroom activities, helping them tailor instruction and interventions accordingly.
- Proactive intervention: The app's insights and predictive capabilities allow teachers to take a proactive approach in managing challenging behaviours or meltdowns, providing early intervention and support to prevent or minimise disruptions.
- Consistent support: The mobile app ensures consistent support for the girl's individual needs and accommodations, regardless of the teacher's level of expertise or understanding.
- Data-driven insights: The app's data collection and analysis capabilities provide valuable insights into the girl's engagement patterns, triggers, and individualised strategies that optimise her learning experience.
- Enhanced collaboration: The app facilitates seamless communication and collaboration between teachers, parents, and specialists, enhancing the sharing of information and coordinated efforts to support the girl's educational journey.
- Improved peer understanding: Peers have a better understanding of the girl's conditions and unique challenges through the app's educational resources and shared insights, fostering empathy, acceptance, and inclusive interactions.
- Optimised classroom environment: With the insights from the app, teachers can optimise the classroom environment to better support the girl's specific needs, minimising challenges and enhancing her engagement and learning experience.
- Increased empowerment and self-advocacy: The app empowers the girl by providing opportunities for self-expression, self-advocacy, and understanding her own patterns and needs, fostering her sense of agency, autonomy, and overall well-being.
- Comprehensive understanding: Teachers gain a more comprehensive understanding of the girl's sensory sensitivities, executive functioning difficulties, and the interplay of her autism and ADHD symptoms, enabling them to create a more inclusive and supportive classroom environment.

WHAT IF A MELTDOWN DOES OCCUR

When a meltdown occurs nevertheless during a lesson, it is crucial for his teachers to respond with empathy and understanding. Here are some strategies for the teacher that can be helpful:

- Maintain calm and safety: Stay calm and ensure the physical safety of the girl and others in the classroom during a meltdown. Remove any immediate threats or triggers from the environment.
- Provide a calm space: Create a designated safe space within the classroom where the girl can retreat to when she needs a break or when the rumble effect occurs. This space should be quiet, calm, and equipped with sensory tools if needed.
- Use visual supports: Utilise visual supports, such as visual schedules, timers, or visual cues, to help the girl understand expectations, transitions, and task completion. Visual aids can provide structure and reduce anxiety.
- Provide clear instructions: Use clear and concise language when giving instructions, breaking down tasks into smaller, manageable steps. Repeat or rephrase instructions if necessary and check for comprehension.
- Incorporate movement breaks: Allow for frequent movement breaks during lessons to help the girl release energy and maintain focus. Incorporate short physical activities or stretching exercises to provide sensory input and support regulation.
- Implement individualised accommodations: Work with the girl's individualised education plan or behaviour plan to implement specific accommodations and strategies tailored to her needs. This may include preferential seating, additional time for tasks, or the use of assistive technology.
- Teach coping strategies: Teach the girl coping strategies for emotional regulation, such as deep breathing exercises, self-calming techniques, or mindfulness exercises. Provide visual reminders or cues for her to utilize these strategies independently.
- Collaborate with specialists: Work closely with specialists, such as occupational therapists or behavioural therapists, to develop and implement individualised strategies that address the specific needs of the girl. Collaborate and seek their guidance when meltdowns occur.
- Communicate with parents: Maintain open communication with the girl's parents or caregivers, sharing observations, strategies, and progress. Collaborate with them to ensure consistency between the home and school environments.
- Foster peer understanding and support: Educate the classmates about autism, ADHD, and the unique challenges the girl may face. Encourage empathy, understanding, and inclusion, promoting a supportive classroom environment.

Gender: male

Age: 10

Diagnosis: ASD level 4

Symptoms: Severe communication challenges, limited or no verbal communication abilities, heightened sensory sensitivities, difficulty with transitions, stereotyped and repetitive behaviours, rigidity and resistance to change, sensory overload, rumble effect, meltdowns, restricted interests, difficulty with social interaction, limited self-expression and self-advocacy, executive functioning difficulties, limited understanding of social cues and non-verbal communication, challenges with independent functioning

School: Attends mainstream education primary school

A typical persona of a 10-year-old boy with autism level 4 may exhibit the following characteristics:

- Severe communication challenges: The boy has limited or no verbal communication abilities, and he relies on alternative communication methods such as AAC devices, sign language, or gestures to express his needs and wants.
- Sensory sensitivities: He has heightened sensory sensitivities, being particularly sensitive to loud noises, bright lights, certain textures, or specific smells. These sensory stimuli can overwhelm him and contribute to the rumble effect.
- Difficulty with transitions: Transitions between activities or changes in routine are extremely challenging for the boy. Sudden changes may cause significant distress, leading to the rumble effect and potential meltdowns.
- Stereotyped and repetitive behaviours: He engages in repetitive movements or behaviours such as hand-flapping, rocking, or repeating words or phrases. These behaviours serve as a source of comfort and predictability for him.
- Rigidity and resistance to change: The boy has a strong preference for routine and sameness. Any disruptions or unexpected changes to his environment or schedule can trigger the rumble effect and potential meltdowns.
- Sensory overload: The boy experiences sensory overload in busy or overwhelming environments, such as crowded classrooms, noisy hallways, or during periods of high stimulation. This sensory overload can contribute to increased agitation and distress.
- Rumble effect: The rumble effect occurs when the boy starts to experience increasing stress, anxiety, or sensory overload. This manifests as restlessness, heightened agitation, increased stimming behaviours, or withdrawal.
- Meltdown: If the rumble effect is not effectively addressed, it will escalate into a meltdown. During a meltdown, the boy exhibits intense emotional and behavioural reactions, including crying, screaming, self-injurious behaviours, or aggression.

WITHOUT AI-TOP

Teachers have limited understanding of the specific needs, triggers, and communication methods of the boy with ASD Level 4. This hinders their ability to effectively support and engage him in the classroom. The boy's limited verbal communication abilities make it challenging for teachers to accurately understand his needs, preferences, and level of engagement. Support for the boy's individual needs and

accommodations varies depending on the teacher's understanding and familiarity with ASD Level 4. The classroom environment is not optimised to support the boy's specific needs, potentially leading to increased challenges and difficulties in engagement. His teachers have limited awareness of the boy's sensory sensitivities, restricted interests, and the interplay of his ASD Level 4 symptoms.

WITH AI-TOP

The development of our innovative app that can infer the level of engagement of students with autism and predicted "meltdown" moments could have a significant impact on the boy described earlier. Here's how it could positively affect the girl:

- Enhanced understanding: The mobile app provides teachers with a better understanding of the boy's needs, triggers, and communication methods, allowing for more effective support and engagement.
- Improved communication: The app enables teachers to better communicate and understand the boy's needs, preferences, and engagement levels through alternative communication methods or visual supports.
- Proactive intervention: The app's insights and predictive capabilities allow teachers to take a proactive approach in managing challenging behaviours or meltdowns, providing early intervention and support to prevent or minimise disruptions.
- Consistent support: The mobile app ensures consistent support for the boy's individual needs and accommodations, regardless of the teacher's level of expertise or understanding.
- Data-driven insights: The app's data collection and analysis capabilities provide valuable insights into the boy's engagement patterns, triggers, and individualized strategies that optimise his learning experience.
- Enhanced collaboration: The app facilitates seamless communication and collaboration between teachers, parents, and specialists, enhancing the sharing of information and coordinated efforts to support the boy's educational journey.
- Improved peer understanding: Peers have a better understanding of the boy's condition and unique challenges through the app's educational resources and shared insights, fostering empathy, acceptance, and inclusive interactions.
- Optimised classroom environment: With the insights from the app, teachers can optimise the classroom environment to better support the boy's specific needs, minimising challenges and enhancing his engagement and learning experience.
- Increased empowerment and self-advocacy: The app empowers the boy by providing opportunities for self-expression, self-advocacy, and understanding his own patterns and needs, fostering his sense of agency, autonomy, and overall well-being.
- Comprehensive understanding: Teachers gain a more comprehensive understanding of the boy's sensory sensitivities, restricted interests, and the interplay of his ASD Level 4 symptoms, enabling them to create a more inclusive and supportive classroom environment.

WHAT IF A MELTDOWN DOES OCCUR

When a meltdown occurs nevertheless during a lesson, it is crucial for his teachers to respond with empathy and understanding. Here are some strategies for the teacher that can be helpful:

- Maintain calm and safety: Stay calm and ensure the physical safety of the boy and others in the classroom during a meltdown. Remove any immediate threats or triggers from the environment.
- Provide a calm space: Create a designated safe space within the classroom where the boy can retreat to when he needs a break or when the rumble effect occurs. This space should be quiet, calm, and equipped with sensory tools if needed.
- Respect communication preferences: Understand and respect the boy's communication preferences and abilities. Utilise alternative communication methods, such as visual supports, picture cards, or assistive technology, to facilitate understanding and expression.
- Predictability and visual supports: Establish a structured and predictable routine using visual schedules, visual cues, and clear visual instructions. This helps provide predictability and minimise anxiety related to transitions or changes in activities.
- Sensory regulation techniques: Offer sensory regulation techniques that may help the boy self-regulate, such as deep pressure activities, fidget tools, or access to a sensory break area. These strategies can assist in managing sensory overload and reducing the rumble effect.
- Collaborate with support staff: Work closely with support staff, such as special education teachers, therapists, or behavioural specialists, to develop and implement individualised strategies and interventions that address the specific needs of the boy.
- Individualised support plan: Develop and implement an individualised support plan, including accommodations and modifications based on the boy's unique needs and goals. This plan should outline strategies to prevent or minimise the rumble effect and meltdowns.
- Empathy and patience: Approach the boy with empathy, understanding, and patience. Recognise that his behaviour is a form of communication, and try to decipher his needs and triggers. Avoid punitive measures and instead focus on providing support and understanding.
- Involve parents and caregivers: Maintain open lines of communication with the boy's parents or caregivers. Collaborate and exchange information regarding successful strategies, triggers, and support at home and in the classroom.
- Ongoing professional development: Engage in ongoing professional development and seek guidance from specialists or professionals experienced in supporting individuals with ASD Level 4. Continually learn about new strategies and approaches to provide the best possible support for the boy.
- By implementing these strategies and providing a supportive and understanding environment, teachers can help minimise the rumble effect, support the boy's engagement and well-being, and create an inclusive educational experience.

AI-TOP - 2020-1-UK01-KA201-079167

Co-funded by the
Erasmus+ Programme
of the European Union

Gender: Male

Age: 14

Diagnosis: ASD (High functional) + OCD (Obsessive Compulsive Disorder)

Profile: Sensitivity to sensory stimuli, intrusive thoughts and anxiety that significantly impact the student's ability to concentrate and focus on their schoolwork, rituals and compulsions, rigid way of thinking which prevents him from developing practices that would help him with controlling his obsessions, intense urge to repeat certain actions (such as touching the objects twice, washing his hands very often without needing to do so etc.).

School: Mainstream with 1:1 support

Personal note: "I think my OCD is more challenging for me than my ASD and that's because it's as if it conquers me and I cannot control it. I may repeatedly check my backpack or desk, wash my hands excessively, or arrange objects in a specific way. These behaviors can interfere with my ability to complete tasks, participate in classroom activities, and keep up with the pace of the class. I need time to handle my obsessive thoughts and carry out all these rituals and this makes me lose time. I have difficulty in keeping up with the rest of the class and this lowers my self-esteem. Moreover, it creates difficulties in my social life as people find it weird to see me do all these rituals and feel embarrassed to be with me."

Without AI-TOP: Teachers lacked knowledge on ASD in combination with OCD which, in fact, constitutes a very challenging situation in class. Some of them tried to eliminate his anxiety by lowering their voice or show that they are understanding and supportive but others, who had ignorance, often told him off for being engaged in his rituals or for doing the same actions again and again. This led the student to feel embarrassed or ashamed of his symptoms and attempt to hide his behaviours and suppress his need to repeat things. As a result, his anxiety grew bigger and he had intense meltdowns. This, in turn, led to social isolation, difficulty forming friendships, and hindered the student's ability to participate in group work or class discussions.

With AI -TOP: The use of the app helped teachers gain knowledge and insight into the indicators of the upcoming meltdown event. They were led to learn to identify the triggering factors and create a classroom environment free of stimuli that could lead to intense dysregulation. Using the app, they were able not only to detect the upcoming meltdown but also apply practices that would restrain it. Teachers became more

observant and gradually they could detect on their own the student's dysregulation. They were helped to grow both, professionally and personally and they were able to cater for more inclusive learning environments. The student felt that he was being understood and accepted and his classmates were taught how to handle some challenging behaviours and how not to pass judgement on him for actions that are beyond his control. Last but not least, AI-TOP training offers valuable input to teachers to adapt the student's academic performance. The challenges posed by OCD can affect a student's academic performance. The time and mental energy spent on managing intrusive thoughts, rituals, or anxiety may leave the student with less time and focus for studying and completing assignments. This can lead to difficulties in meeting deadlines, lower productivity, and challenges in understanding and retaining information. AI TOP pedagogical framework can offer all the knowledge needed in order to apply certain adaptations.

What if a meltdown does occur:

In case a meltdown occurs, teachers should do the following:

-Provide support: It's essential for the teacher to stay calm and composed during the meltdown. This can help create a sense of stability and safety for the student. Avoid reacting with frustration or anger, as it may escalate the situation further and provide support either by using a low and steady tone of voice or by using visual prompts to guide them as to what they need to do.

-Create spaces: Make sure there is a special place in class where the student can experience a meltdown safely, without being in the center of attention and feel looked at.

-Respect personal boundaries: During a meltdown, the student may display certain behaviors such as rocking, hand-flapping, or vocalisations. Respect their personal boundaries and avoid touching or restraining them, unless it is necessary for their safety or the safety of others.

-Minimise sensory input: Sensory overload can contribute to meltdowns in individuals with ASD and OCD. Dim the lights, reduce noise levels, and remove any potential triggers or sources of distress in the environment. This can help create a more soothing atmosphere and aid in the student's self-regulation.

-Allow for a cooling-off period: After the student's meltdown, provide them with some time to calm down and collect themselves. This may involve taking a break, engaging in a calming activity, or using relaxation techniques. Respect their need for space and avoid pressuring them to re-engage immediately.

-Communicate with parents or guardians: Keep open lines of communication with the student's parents or guardians. Inform them about any meltdowns or challenging situations that occur in the classroom, and work together to develop strategies and interventions that can support the student's well-being and academic progress.

-Organise awareness events: Unfortunately, there is still a lack of awareness and understanding about OCD in many communities. The stigma associated with mental health conditions can create additional challenges for students with OCD. They may face misconceptions, judgment, or bullying from peers or even educators, which can negatively impact their self-esteem and overall well-being. By organising awareness events, the

school community (teachers, students, parents) as well as the local society will be informed on OCD (and ASD) and will know how to act and behave towards people who are suffering from this comorbidity.

4   References

- Minocha S (2009) A Study on the Effective Use of Social Software by Further and Higher Education in the UK to Support Student Learning and Engagement (Final Report); JISC Learning and Teaching Committee; The E-learning Programme; The Open University UK; https://www.webarchive.org.uk/wayback/archive/20140613220103/http://www.jisc.ac.uk/media/documents/projects/effective-use-of-social-software-in-education-finalreport.pdf downloaded at 23/05/2023;

- Standen, P & Burton A (2013); ViPi Educational and Pedagogical Framework available from https://isrg.org.uk/wp-content/uploads/2023/05/ViPi_Pedagogical_framework.pdf downloaded at 23/05/2023

- Standen, P; Hughes-Roberts, T; Burton, A; EduRob Educational and Pedagogic Framework available from https://www.edurob.eu/assets/EdurobPedagogicFramework.pdf at 23/05/2023

Co-funded by the
Erasmus+ Programme
of the European Union

Annex 1: Structured Interview Ethics Documents

AI-TOP Study Description

AI-TOP – A study to create an engagement tracking and rumble moment prediction technology for students with Autism Spectrum Disorder (ASD)

Tracking a student's engagement with their learning and prevention of meltdown events has the potential to increase effective learning in schools. A technology which could alert the teacher to signs of low engagement or early signs of a meltdown event could allow the teacher to implement strategies to mitigate events in the classroom. AI-TOP aims to develop this technology. To help you decide whether to take part, this sheet explains why the research is being done and what it would involve for you. Please kindly take the time to read the following information carefully.

What is the purpose of this study?

Teachers often face challenges in dealing with the wide variety of learning needs in inclusive classrooms that include students with autism spectrum disorder. The challenge of this project is to use sensor data which may include eye-gaze, facial expressions, heart rate, skin temperature and body posture as indicators, for gauging the engagement of students, and for the prediction of rumble moments and meltdown events. This could in turn assist the creation of personalised learning pathways, to ensure all students with ASD reach their full potential.

A machine learning algorithm will be developed to find the patterns between the sensory data and attention levels and rumble moments. If successful, the technology could enable the teacher to intervene using different interventions - teaching techniques, learning material, classroom setups and environmental factors - to maintain attention and engagement or to prevent rumble/meltdown events in the classroom before they happen.

What will I be expected to do if I take part?

Researchers at NTU and our partner organisations in the project will be conducting semi-structured interviews to understand your thoughts on the project. We will be working to establish which technologies and sensors would be most appropriate and acceptable for you and your students to use in the classroom, to identify practical limitations and barriers in the potential implementation of these sensors and technologies in a real-life school classroom environment, and to identify the potential benefits which could be gained by the implementation of such technologies.

What are the potential benefits of taking part?

Taking part in this study will lead to the development of a technology that may have direct impact on the quality of the students' learning experiences in the classroom. If this study is successful, the AI-TOP partners will promote the adoption of the technologies in a wide variety of inclusive education settings for monitoring attention and engagement of students who face learning and behavioural challenges, to improve educational practices. This approach will mean tutors will have a tool to track and compare how effective their approaches and learning materials are for each student, and offers a customized approach per student – based on their individual needs, to ensure all students reach their full potential and to promote their inclusion in mainstream education.

Will it cost me anything to take part?

It will not cost you anything to take part. All costs are covered from the research budget.

Will my taking part in the study be kept confidential?

Yes. We will follow established ethical and legal practices and all information about you and your school/organisation will be handled confidentially. All information which is collected about you during the study will be kept strictly confidential and any information about you will have your name and identity removed so you cannot be identified prior to any analysis or publication of results.

What data will be collected?

No long term personally identifiable information will be collected for this study. Your consent will be requested for all the data collected in the study. For publication all data will be anonymized and no records of name or data leading to the identification of the participants will ever be made public. At no point will any image or video data be stored for long term or public publication.

What will happen if I don't want to carry on with the study?

Your participation is voluntary and you are free to withdraw at any time, without giving any reason and without your legal rights being affected. If you withdraw the information collected from you will be destroyed.

What will happen to the results of the research?

It is intended that the results of the research will be published formally in scientific journals and published in end user community newsletters. You will not be identified in any report or publication.

Our genuine thanks for your time in reading this information pack.

Contact Information
Dr. Andy Burton
E-mail: removed
Nottingham Trent University
Research Fellow

Informed Consent Form

I, the undersigned, confirm that (please tick box as appropriate):

1.	I have read and understood the information about the project, as provided in the Information Sheet dated _____.	☐
2.	I have been given the opportunity to ask questions about the project and my participation.	☐
3.	I voluntarily agree to participate in the project.	☐
4.	I understand I can withdraw at any time without giving reasons and that I will not be penalised for withdrawing nor will I be questioned on why I have withdrawn.	☐
5.	I agree to an audio recording of the interview being made for transcription purposes.	☐
6.	The procedures regarding confidentiality have been clearly explained to me. (e.g. use of the audio recording, names, pseudonyms, anonymization of data, etc.)	☐
7.	The use of the data in research, publications, sharing and archiving has been explained to me.	☐
8.	I understand that other researchers will have access to this data only if they agree to preserve the confidentiality of the data and if they agree to the terms I have specified in this form.	☐
9.	I, agree to sign and date this informed consent form.	☐

Participant:

_____   _____   _____
Name of Participant   Signature   Date

Researcher:

_____   _____   _____
Name of Researcher   Signature   Date

Annex 2: Structured Interview Protocol

Focus groups (Semi Structured interviews and Thematic Analysis)

Note to interviewers:

1. Ensure the project information sheet has been read and that the consent form has been completed and signed.

2. Remember to record the audio of the interview for transcription purposes.

3. Use the following questions and prompts to complete the interview.

AI-TOP Structured Interview Questions

CHILD'S PROFILE

What age is your child? / What ages are the children you work with?

Is your child male or female? / Do you work with single sex classes (if so which?) or mixed classes?

(Teachers only) How many children with autism are in your class?

(Teachers only) How many years teaching experience do you have?

What is the child's diagnosis? / Can you describe the range of diagnoses of the children you work with?

What is the level of functioning of the child/children with autism?

Does your child experience sensory sensitivities? Do any of the children have sensory sensitivities?

Can you describe them?

EXPERIENCING A MELTDOWN

Where does your child develop a meltdown most usually?

outdoor, during a walk or an activity, at school, at home, at crowded places, at unknown places, somewhere else?

How is a meltdown manifested in your child's behaviour? (Please be descriptive)

Have you identified any triggering factors?

(If yes) What are these factors?

What strategies do you use to diffuse a meltdown?

Do you employ any interventions or strategies to anticipate your child's challenging behaviour?

Do you think meltdowns are milder when you have previously informed your child about what happens next (smooth transition practices)?

EDUCATIONAL SETTING

What type of school setting does the child attend? What type of school do you work in?

Special education school/Mainstream school with individualized support/Home-schooling/…others

Tell us about the (child's) classroom environment.

What is the classroom like?

Is there a quiet corner to resort to when they experience a meltdown? / Does your classroom have a quiet corner to resort to when they experience a meltdown?

How many children and teachers/TAs are present?

Are they usually seated and in the same seats?

Do people move around?

Are there specific individuals from a group that we would need to track?

TECHNOLOGY

Does your child use technology? (mobile phones, tablets, laptops etc.)/ Do the children in your class get to use technologies?

Which technologies do they have access to - mobile phones, tablets, laptops, others?

Do they use them alone or with assistance?

What are your views on tracking engagement and signs of meltdown in students with autism using sensors (e.g., cameras, accelerometers, heart rate sensors, heart rate variability sensor, smart watches)?

Which of these sensors would you consider to be more acceptable and well tolerated?

Is your child calmer when engaged in digital activities they like and are familiar with? / Are the children in your class with autism calmer when engaged in digital activities they like and are familiar with?

(if yes) Can you give any examples of such activities?

What is -on average- their attention span when engaged in such activities?

DATA

Do you have concerns about how the sensor data is stored, analysed or transferred?

FEEDBACK

How would you like the system to output its analysis of student engagement and early signs of meltdown? (e.g. such methods as a traffic light system, dashboard, audio feedback)

What should we do with the system's output on student engagement and early signs of meltdown events?

So the system spots an event, say, the child has become disengaged, or is showing signs of moving towards meltdown. What should the app do with this information?

Co-funded by the
Erasmus+ Programme
of the European Union

Annex 3 – A Visual Representation of the Framework

This diagram is not intended to replace, but to complement and to help to summarise the textual information given in the document

Educational questions	Educational directives
How would the user benefit from the AI-TOP engagement or emotional dysregulation prediction software?	Use the software only to target specific users where it is appropriate.
How motivated are they? Is there a particular feature that you would be more interested in for the user (e.g. their engagement level, or prediction of emotional dysregulation?)	
What interventions will I use if the system detects an event? a. Dis-engagement b. Onset of emotional dysregulation	Customised content, Differentiated instruction, sensory supports, emotional regulation strategies
Would the use of the AI-TOP setup detract from their engagement with the class? Is the student easily distracted by having a PC in from of them? Could you keep the machine away from them and just have a wired or better still, wireless USB camera in front of them?	

Organisational questions	Organisational directives
Is there sufficient support for the initiative inside the organisation?	The organisation must be supportive of the introduction of AI-TOP and possess an appropriate pedagogic culture.
Do the trainers themselves feel confident using the AI-TOP tools?	Train trainers in using AI-TOP Ensure trainers have received the AI-TOP handbook and are trained in strategies to increase engagement or to avert meltdowns.
How will using AI-TOP tools fit in with the classroom environment? Does it need to be augmented or altered in any way?	Staying informed about emerging technologies, research, and best practices, and being willing to adjust and adapt the use of AI technology to meet the changing needs of students and the school community will provide the best outcomes.
Who would carry/wear the receiving device?	Promotion of and education about of AI-driven technology within the parent cohort.

Social Questions	Social directives
Would the use of the AI-TOP software with some members of the class benefit other members of the class?	
Can peers help to increase engagement with learning materials?	Providing structured opportunities for students with ASD to share their perspectives, ideas, and contributions, and by promoting a culture of inclusivity, respect, and acceptance among all students.
Does working with peers initiate emotional dysregulation?	

Technological questions	Technological directives
Does the organisation have enough suitable PCs for the system to be adopted. Is there sufficient technical support within the organisation/school to enable use of the AI-TOP system?	Schools need to ensure that they have the necessary infrastructure and technology access to support the implementation of AI-driven tools and services. This may include having reliable internet connectivity, appropriate hardware and devices.
Are administrator privileges available to install the software locally – or is the IS provider available to set up the software on the classroom PCs?	Teachers and staff need to receive adequate training and professional development to effectively implement and use AI-driven tools and services with students with ASD..
Can permissions be set to allow the PC software to contact the mobile app on the teacher's device? **review this when we know how it will work**	Schools need to ensure that the use of AI-driven tools and services complies with relevant data privacy and security regulations. This includes protecting student data, ensuring that data is collected, stored, and used securely, and obtaining appropriate consent from parents/guardians
Does the teacher have access to a mobile device capable of installing the app and therefore receiving the traffic light codes sent by the system. Battery life and charging of this device should also be considered.	

Co-funded by the
Erasmus+ Programme
of the European Union