Atollo Project

Breaking barriers through education

D4.1 A report summarising the findings of the pilot testing

A comprehensive evaluation report summarising the findings from the pilot testing. A detailed evaluation report.

30/11/2025 | Gran, Bjørgen, Fritze, Alimović, Dimitrov & Pace

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Table of Contents

Acknowledgement

We would like to extend our sincere gratitude to the participating schools in Frankfurt (Germany), Bulgaria, and Croatia for their invaluable contributions to the Atollo project. Their commitment and engagement have been essential to our work. We deeply appreciate the teachers, classroom assistants, parents, guardians and school leaders who took part in the focus group interviews, completed the questionnaires, wrote letters and, most importantly, piloted the various digital learning resources developed within the project. Their openness, constructive feedback, and dedication to inclusive education have provided crucial insights that significantly strengthened the project`s outcomes and relevance for learners with special educational needs across Europe.

Executive summary

This report presents the evaluation procedure and criteria established for monitoring and assessing the digital educational content developed in the Atollo project. Aimed at enhancing the educational experiences of children with special educational needs, this comprehensive evaluation incorporates a mixed-methods approach, including classroom observations, questionnaires, focus group interviews, letter method and statistical analyses. The primary findings will highlight the presence of user engagement and the level of accessibility.

Deliverable D4.2 established the methodological foundation for monitoring and evaluating the digital learning resources, providing a clear framework of evaluation procedures and criteria developed in line with the requirements of the European Union (EU) for quality, inclusion, and impact assessment. This report (D4.1) presents the outcomes of the evaluation as it has been carried out in practice. It builds directly on the objectives, indicators, and methods defined in D4.2, demonstrating how these elements guided the data collection, assessment processes, and overall analysis of the resources' functionality, usability, and pedagogical value. Thus, D4.1 serves as a synthesis and application of the framework introduced in D4.2, documenting the extent to which the resources meet the quality expectations set by the EU for the project.

Feedback from participating educators highlighted the demand for whole-class instructional modes alongside individualized pathways, emphasizing the need for clear guidance on teacher circulation within the classroom. While technical challenges such as Wi-Fi reliability were identified, recommendations were provided to develop offline capabilities and low-bandwidth options to ensure continual access to digital resources.

Teachers would like the text load to be reduced, the resource levels to include more fine-grained sub-levels, the interactive elements to be improved, and the accessibility updates to be completed so the materials meet WCAG standards (World Wide Web Consortium, 2020). Additional steps involve the completion of statistical analyses, content revisions based on gathered findings, and the preparation of an Inclusive Digital Education Toolkit to assist educators in effectively utilizing the resources. This toolkit aims to serve as a comprehensive guide for teachers, facilitating collaboration across the EU in special education using digital resources. In conclusion, this evaluative effort not only aims to optimize the digital tools created under the Atollo project but also strives to establish a robust framework for ongoing dissemination and endorsement by public authorities, ensuring that these resources are widely accessible and beneficial to educators and students alike.

1. INTRODUCTION

As digital learning environments continue to evolve, ensuring accessibility, inclusion, and high-quality educational experiences has become a central objective in European educational initiatives. Within this broader context, the Atollo project represents a targeted effort to strengthen the development, evaluation, and implementation of digital learning resources for learners with disabilities. Building on shared European priorities for equity and quality education, the project brings together partners across countries to design, test, and refine tools that support diverse learning needs. The following section provides an overview of the Atollo project's aims, structure, and key activities.

1.1 About the Atollo project

The Atollo project has progressed beyond its mid-point and is entering a decisive phase in its implementation. Its overarching objective is to empower learners with disabilities through the development of inclusive and high-quality digital learning materials. High-quality digital learning materials in Atollo refer to web-based educational resources, designed by subject experts in mathematics and digital skills. They provide structured, curriculum-aligned content that is accessible, pedagogically sound, and adaptable to the needs of diverse learners.

As the project advances, the focus now shifts toward refining these resources, expanding their multilingual availability, and ensuring they can be effectively used by teachers and learners across Europe and Australia. The following section presents the digital tools piloted within the Atollo project and highlights how they are being tested and refined to support accessible and inclusive learning for students with diverse needs.

The consortium comprises partners from Croatia, Bulgaria, Austria, Germany, Iceland, Norway, Ireland, and Australia, representing universities, SME's, EdTech companies, schools for children with special educational needs (SEN), public authorities, and non-governmental organisations.

Following the initial phases of research, analysis, and design, the pilot testing of the newly developed digital learning resources has been successfully completed across several partner institutions. The piloting phase has provided valuable empirical evidence and user feedback from teachers, learners, guidance and experts concerning the functionality, accessibility, and pedagogical value of the materials.

The digital resources in the IZZI Digital bookshelf developed in Atollo project, consist of interactive learning modules designed specifically for students with special educational needs. The materials cover two main subject areas: Information and Communication Technology (ICT) and mathematics. Each resource includes visually clear tasks, step-by-step guidance, and adaptive difficulty levels that support diverse learners. The modules can be used individually or in small groups and provide teachers with flexible tools to plan and deliver inclusive lessons. Through structured activities, visual supports, and accessible design, the resources aim to strengthen foundational ICT skills and mathematical understanding for learners who require additional support.

An important finding from the joint analyses conducted during the recent physical partner meeting in Ireland is the growing recognition that the impact of digital learning resources depends not only on their design and

accessibility but also on the learning environment surrounding the learners. Research indicates that digital tools achieve their full potential when integrated into a pedagogical framework that considers representation, engagement, and motivation. For instance, Bucheli et. al (2024) show that digital technologies can effectively support Universal Design for Learning (UDL) principles, enhance student engagement and learning outcomes in higher education within the context of the Sustainable Development Goal 4 (SDG 4) (Boeren, 2019, p.278).

SDG 4 focuses on ensuring "inclusive and equitable quality education" and promoting "lifelong learning opportunities for all." It emphasises access, participation, and meaningful learning outcomes for learners who are often excluded, including children and young people with disabilities and complex learning needs. The Atollo project directly contributes to SDG 4 by developing and testing digital learning resources that are designed to be inclusive, motivating, and accessible across diverse learner profiles. By addressing barriers related to usability, accessibility (e.g., alignment with WCAG), and teacher support, Atollo supports schools and teachers in realising SDG 4 in everyday classroom practice, not only at the policy level but in concrete teaching and learning situations (United Nations, 2015).

Boeren (2019, p.281) emphasizes that SDG 4 on "quality education" must be understood across three levels: the micro level (individual learners), the meso level (schools and educational institutions), and the macro level (policy and governance). For the Atollo project, this means that developing digital learning resources for children with special needs is not only about designing accessible and meaningful tasks for individual students, but also about supporting teachers and schools in implementing these tools effectively (meso level), while aligning the work with national inclusion policies, quality indicators, and broader educational goals (macro level). In this way, the project contributes directly to achieving SDG 4 for a group of learners who are often overlooked in mainstream quality assessments.

1.2 About the work package 4 (WP4)

This report aims to present concrete recommendations for improvement based on the results of the pilot phase and the collective reflections from project partners. These insights will guide the refinement and enhancement of the digital materials in the forthcoming period towards the publication of the digital resources in April 2026.

Atollo applies a user-centred and inclusive design approach to ensure that the digital resources respond to the diverse needs of learners with disabilities. The next stages of the project will focus on systematic revision of the resources and on developing an Inclusive Digital Education Toolkit that offers practical, evidence-based guidance for educators, policymakers, and institutions.

Through its collaborative and research-informed approach, the Atollo project strengthens teachers' capacities, improves learning opportunities for students with disabilities, and advances the broader agenda of inclusive education in Europe and beyond.

WP4 is coordinated by the University of Inland Norway and the University of Zagreb, led by Lillian Gran and Sonja Alimović. In Bulgaria, Petya Dimitrova from RCSIE conducted focus group interviews and contributed to the report development. The main aim of WP4 is to analyse digital learning resources specifically designed for children with special educational needs (SEN). The activities include organising focus groups, transcribing and translating data, conducting detailed analyses, and distributing questionnaires to assess the effectiveness and accessibility of these resources.

Deliverable D4.1 presents the main outcomes of the pilot testing conducted in 15 schools across the partner countries Croatia, Germany and Bulgaria. The participating universities have closely monitored the implementation process and gathered extensive data through multiple sources. This includes responses from Questionnaire 1 and Questionnaire 2, which together capture teachers and assistants perspectives before and after using the digital learning resources, as well as usage data collected through Google Analytics to track engagement, navigation patterns, and interaction with the digital content.

The evaluation addressed both pedagogical and technical dimensions, examining how the materials support learning, accessibility, and inclusion, while also ensuring that they are user-friendly, stable, and adaptable to diverse educational settings. The digital resources are developed to be in line with European guidelines for universal design, including the European Accessibility Act (Directive (EU) 2019/882) and related EU standards on

accessible information and communication technologies, to ensure compliance with recognised principles of accessibility and usability for all learners.

In addition, classroom observations were conducted in pilot schools in Germany, Bulgaria, and Croatia to gain a deeper understanding of how the digital resources were implemented in real classroom contexts. These field observations provided valuable qualitative data on teacher practices, student engagement, and contextual factors affecting the successful use of digital materials. In Croatia, the Ministry of Labour, Pension System, Family and Social Policy also participated actively in the process, contributing to the evaluation and ensuring that the outcomes align with national educational and inclusion policies.

Seven focus group interviews with teachers were organised to gather in-depth reflections on each unit and component of the digital content. These reflections offered important insights into how the resources function in authentic school environments and how they can be further improved. During the recent physical partner meeting in Ireland, a collective analysis of all data sources was undertaken. Partners emphasised that the effectiveness of digital learning resources depends not only on their technical and pedagogical quality but also on the learning environment surrounding the learners. Supportive school contexts, teacher collaboration, and inclusive pedagogical practices were identified as essential conditions for meaningful learning and successful implementation. Deliverable D4.1 summarises the evaluation procedures, integrates quantitative and qualitative findings, and identifies key areas for improvement. The insights gained will guide the next phase of refinement and feed directly into the development of the Inclusive Digital Education Toolkit.

1.3 Summary of evaluation procedure (D4.2)

The report of D4.2 outlined the evaluation procedure and criteria developed under the Atollo project for assessing digital educational content tailored specifically for students with cognitive and learning difficulties. The primary objective of the evaluation framework is to ensure that these digital materials are effective and inclusive, ultimately fostering an equitable learning environment. The evaluation procedure combined quantitative and qualitative data sources, including teacher and assistant questionnaires (pre- and post-use), classroom observations, focus group interviews, and usage data from Google Analytics. The design of the evaluation was grounded in user-centred and inclusive design principles for diverse learners and aligned with the broader SDG 4 agenda on quality and inclusive education for learners with disabilities (Boeren, 2019). In addition, the evaluation framework and preliminary findings were presented at the ECER 2024 conference (Gran, Bjørgen, & Fritze, 2024), where the work received peer-reviewed feedback from fellow researchers and experts. These inputs have been used to further refine both the digital resources and the evaluation tools employed in work package 4 (WP4).

Key components of the evaluation include:

Feedback Collection: The document details a comprehensive approach to gather feedback from various stakeholders such as teachers, parents and guardians, and students. This feedback is critical for evaluating the impact of the educational resources on learning outcomes, engagement levels, and classroom participation.

Data Collection Methods: The report emphasizes utilizing a combination of methodologies, including questionnaires, interviews, classroom observations and focus groups, to gain in-depth insights into the usage of the digital resources.

Implementation and Impact Assessment: The framework aims to systematically assess how well the digital learning materials are integrated into educational environments and their effect on user experience. This includes ensuring compliance with data protection regulations (GDPR) and addressing any technical challenges faced during implementation.

Deliverables of WP4: The report outlines the deliverables associated with Work Package 4 (WP4), including the summarization of pilot testing findings (D4.1), the current evaluation procedure (D4.2), optimized digital content units (D4.3), an Inclusive Digital Education Toolkit (D4.4), and educational sessions for parents (D4.5).

During the evaluation, an important methodological adjustment was identified after the focus group interviews. A planned “think-tank” for students was not implemented, but the underlying need to strengthen pupils’ and teachers own voices led to two supplementary approaches. First, a letter-based reflection method, was introduced,

allowing teachers who did not take part in the focus group interviews, to describe their experiences with the digital resources individually and in their own tempo. Second, during school visits in the pilot phase, staff from the Ministry of Labour, Pension System, Family and Social Policy and local partners asked pupils directly to indicate their views by pointing at smiley faces while the lessons were being observed. Together, these low-threshold and visually supported response formats made it easier for students with diverse needs to express themselves and complemented the focus group data.

1.4 A report summarising the findings of the pilot testing (D4.1)

This report (D4.1) presents the findings from the pilot testing of the digital learning resources developed within the Atollo project ERASMUS-EDU-2023-PI-FORWARD-LOT1. It builds upon the foundation laid in the first WP4 deliverable, *Evaluation Procedure and Criteria for Monitoring and Evaluating Digital Educational Content* (D4.2), which outlined the evaluation framework, ethical considerations, data collection methods, and criteria used to ensure that the digital resources are pedagogically sound, technically robust, and inclusive for learners with diverse needs. It also draws on the work conducted in WP2, where partners carried out a cross-country curriculum analysis with a specific focus on inclusive learning and special education in the participating countries which again led to the choice of using ICT and mathematics as the subjects.

The purpose of this report is twofold: first, to assess the extent to which the developed resources meet the agreed quality standards and curriculum learning outcomes; and second, to provide actionable feedback for refining and optimising the resources prior to their final release. The pilot phase involved systematic data collection using multiple complementary methods, including teacher and guardian questionnaires, semi-structured focus group interviews, classroom observations, technical monitoring, process documentation reviews and letter-writing method. This mixed-methods approach ensured that the evaluation captured both quantitative indicators of effectiveness and rich qualitative insights into user experience.

The findings presented here reflect the collaborative efforts of the Atollo project consortium, involving pilot schools across the partner countries, and are informed by the perspectives of teachers, students, parents or guardians and other stakeholders. In doing so, the report not only evaluates the functionality and pedagogical value of the resources but also examines their accessibility, inclusivity, and potential for long-term integration into everyday teaching practice.

Ultimately, D4.1 serves as a bridge between the design and refinement stages of the Atollo project. The results of the evaluation will be translated into recommendations for improvement. These insights will directly inform the finalisation of optimised learning units (D4.3) and the development of the inclusive digital education toolbox (D4.4), ensuring that the project's outputs align with its overarching goal: to promote equitable, high-quality, and accessible learning opportunities for all students.

This report (D4.1) is part of Work Package 4 (WP4), *Piloting and Evaluation of Digital Educational Content & Quality Assurance,* within the project. The work package is led by University of Inland Norway (INN UNI), which is responsible for three key deliverables:

D4.1 A report summarising the findings of the pilot testing

D4.2 Evaluation procedure and criteria for monitoring and evaluating digital educational content

D4.5 Education sessions for parents/guardians

The purpose of D4.1 is to provide a comprehensive evaluation of how the developed digital educational content performs in practice, based on pilot testing carried out in various school settings. The report compiles experiences, analyses, and assessments that will support the improvement of content, implementation, and quality assurance processes.

The report is publicly available (PU) and will be delivered on 30th of November 2025 in electronic format, in English.

Deliverable	Short description	Responsible partner	Type	Accessibility	Mile-stone	Format language
D4.1 – Report summarizing findings from pilot testing	Detailed evaluation report based on pilot testing of digital teaching resources.	INN	Report	Public	M23	Electronic, EN
D4.2 – Evaluation procedure and criteria	Document describing procedures and criteria for monitoring and evaluating digital educational content in the classroom.	INN	Report	Public	M12	Electronic, EN, 10–20 pages
D4.3 – Optimized digital learning units + guidelines	Ready-to-use digital learning resources with guidance.	PK	Demonstrator /prototype	—	M27	Electronic, EN + translations into other EU partner languages
D4.4 – Inclusive digital education toolbox	Guidelines for developing and using digital resources in inclusive teaching for students with disabilities.	PK	Report	Public	M29	Electronic, EN + translations, 50–70 pages
D4.5 – Training sessions for parents/guardians	Presentations for parents/guardians at pilot schools.	INN	Demonstrator /prototype	—	M30	Electronic, EN + translations into pilot school languages (CRO, BG, DE)

Table 1. Overview of WP4 outputs and deliverables

1.5 Rationale of deliverable

This section describes the purpose and scope of the deliverable, highlighting its role in the later stages of the project. With the piloting of digital educational resources now completed in schools across partner countries, this deliverable focuses on consolidating feedback from teachers, students, and experts, and providing concrete recommendations for improvement. It specifies the objectives addressed, including the assessment of pedagogical effectiveness, technical functionality, and accessibility of the resources, as well as insights from questionnaires, focus groups, classroom observations and analytics data. The scope outlines the content, activities, and contexts covered, ensuring alignment with overall project goals and offering a structured framework for further refinement, evaluation, and implementation of the inclusive digital educational materials.

1.6 The Atollo project consortium

The Atollo project consortium is an Erasmus Partnerships, bringing together 14 partners.

No	Partner	Acronym	Country
1	PROFIL KLETT D.O.O.	PK	HR
2	SVEUCILISTE U ZAGREBU	UNIZG ERF	HR
3	UNIVERSITY OF INLAND NORWAY	INN UNI	NO
4	REGIONALEN TSENTAR ZA PODKREPA NA PROTSESA NA PRIOBSHTAVASHTO OBRAZOVANIE SOFIA GRAD	RCSIE	BG
5	SKOLA ZA ODGOJ I OBRAZOVANJE PULA	STE PULA	HR
6	HASKOLI ISLANDS	UI	IS
7	MATRIX INTERNET APPLICATIONS LIMITED	MATRIX	IE
8	PADAGOGISCHE HOCHSCHULE OBEROSTERREICH	PH OOE	AT
9	MINISTARSTVO RADA, MIROVINSKOGA SUSTAVA, OBITELJI I SOCIJALNE POLITIKE	MRSOP	HR
10	STADT FRANKFURT AM MAIN DER MAGISTRAT, CHARLES HALLGARTEN SCHULE IN GERMANY	CHS	DE

No	Associated Partner	Acronym	Country
11	CENTRAL QUEENSLAND UNIVERSITY	CQU	AU
12	NATSIONALNA ASOTSIATSIA NA RESURSNITE UCHITELI	NART	BG
13	DIGITAL TECHNOLOGY SKILLS LIMITED	DTSL	IE
14	TERAWE TECHNOLOGIES LIMITED	TERAWE	IE

1.7 Document Control Information

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2. THEORETICAL AND EMPIRICAL FOUNDATION

This section establishes the theoretical and empirical foundation for evaluating the usage of the digital learning content developed in the Atollo project. It outlines how established learning theories and previous research on inclusive and digital education inform the evaluation design, including the choice of methods and criteria. The assessment utilizes multiple empirical data sources teacher questionnaires, focus group interviews, classroom observations, and analyses to provide evidence-based insights into pedagogical effectiveness, usability, accessibility, and alignment with learning objectives. By combining theoretical guidance with empirical evidence, the evaluation ensures a robust understanding of how the resources function in real learning contexts.

2.1 Usage of digital resources in inclusive education

Digital resources play a crucial role in supporting inclusive education by providing tools that accommodate diverse learning needs. Research has shown that digital technologies well facilitated, can enhance engagement, facilitate personalized learning, and support students with special educational needs (Samaniego López, 2025). Immersive technologies, for instance, have been shown to improve accessibility and engagement for learners with disabilities (Poggianti et al., 2025). Recent research also supports the assumption that well-designed digital learning resources can promote participation, motivation and learning outcomes for students with special educational needs. Stalmach et al. (2023) show that digitally mediated activities may strengthen self-regulation and engagement for these learners, particularly when tools are carefully aligned with curricular goals, adapted to diverse needs and supported by informed teacher practices. These findings are consistent with the results from the Atollo pilot, where the teachers say pupils with special needs engaged more actively with the content when the digital resources were accessible, clearly structured and embedded in inclusive classroom practices.

The effective integration of digital resources in inclusive settings depends on pedagogical approaches. Strategies such as problem- and project-based learning, cooperative learning, and service learning have demonstrated potential for promoting inclusivity when combined with appropriate digital tools (Zou et al., 2025).

2.2 Inclusive education

Inclusive education seeks to accommodate all learners, regardless of their abilities or backgrounds. Frameworks such as Universal Design for Learning (UDL) emphasize providing multiple means of representation, engagement, and expression to meet diverse learning needs. Empirical studies indicate that inclusive practices, when effectively implemented, improve outcomes for all students (Samaniego López, 2025). Digital inclusion is a central aspect of inclusive education, addressing issues of access, opportunity, and skills in the digital environment. Ensuring that digital learning environments are accessible and equitable is essential for fostering meaningful participation (OECD, 2023).

2.3 Digital resources and learning

The integration of digital resources has transformed educational practices, with evidence showing that digital tools can enhance engagement, support personalized learning, and accommodate varied learning styles when they are well designed and pedagogically grounded (Zou et al., 2025).

Findings from this project, in line with other research, indicate that such resources are most effective when they are carefully aligned with pedagogical objectives and made accessible to all learners (Lomellini et al., 2025). Applying UDL principles in the design and implementation of digital resources further helps ensure that learners with diverse needs, including disabilities, can engage meaningfully and effectively with the content.

2.4 Differences between the countries

The use and impact of digital resources in inclusive education vary across countries due to differences in policy frameworks, infrastructure, teacher training, and cultural attitudes toward inclusion. Disparities in access to digital tools can exacerbate educational inequalities (OECD, 2023). International studies show that while some countries have successfully integrated digital technologies in inclusive education, others face challenges in resource availability and curriculum adaptation, emphasizing the need for context-specific strategies (Samaniego López, 2025).

2.5 Digital learning environment

A digital learning environment that aims to be genuinely inclusive must combine pedagogical coherence, accessibility, and low cognitive load. Recent systematic reviews show that digital technologies can transform classrooms into more inclusive spaces by personalizing content, offering multimodal representations, and reducing participation barriers for learners with diverse needs, including disabilities (Navas-Bonilla et al., 2025; Samaniego López et al., 2025). However, these studies also underline that technology is not inherently inclusive: when interfaces are complex, text-heavy or poorly structured, learners with special educational needs are often the first to be excluded.

Emerging research on Universal Design for Learning (UDL) offers a robust framework for addressing these challenges in digital environments. Meta-analyses and systematic reviews from 2023 onwards document that UDL-based design is associated with improved student outcomes, higher engagement and better participation for students with disabilities in both school and higher education settings (Almeqdad, 2023; Rusconi & Squillaci, 2023). In online settings, UDL provides evidence-based principles for designing platforms that offer multiple means of representation, action/expression and engagement, thereby supporting autonomy and reducing dependency on adult mediation (Utami et al., 2025).

At the same time, large-scale studies on accessibility in European higher education show that many institutions still struggle to provide consistently accessible digital materials and services, with issues such as poor navigation, missing alternative formats and unclear accessibility information (Krejtz et al., 2025; Papadopoulos et al., 2025). These findings resonate with the evaluation of the Atollo environment: teachers highlight that the resources are engaging and motivating, yet point to accessibility barriers, high cognitive load and limited control over scaffolding. This aligns with recent work on inclusive digital education, which stresses that design must explicitly anticipate learner variability and embed flexible supports, rather than treating accessibility as an add-on (Mintz, 2024). In this perspective, Atollo's next development phase should be guided by UDL-informed redesign and systematic accessibility work to ensure that the digital environment truly supports independent and meaningful learning for students with special educational needs.

3. METHODOLOGY

This section introduces the procedures and criteria used to monitor and evaluate the digital educational content developed within the project. It outlines how the implementation of the resources is assessed in terms of pedagogical effectiveness, usability, accessibility, and alignment with learning objectives. The evaluation draws on multiple data sources, including teacher questionnaires, focus group interviews, classroom observations, and analytics, to ensure a comprehensive understanding of how the materials function in real educational settings.

The evaluation framework provides a structured approach for assessing the digital educational content developed within the project. It defines the objectives, methods and criteria for evaluating both pedagogical and technical aspects of the resources, ensuring that the evaluation is systematic, transparent, and evidence based. The framework integrates multiple data sources, including teacher questionnaires, focus group interviews, classroom observations in Germany, Bulgaria, and Croatia, and analytics data from google analytics.

It also emphasizes ethical considerations, such as informed consent, confidentiality, and data protection, to ensure that all participants are treated respectfully and in accordance with legal and professional standards. The evaluation criteria cover key dimensions of quality, including pedagogical effectiveness, accessibility, usability, and alignment with the intended learning outcomes.

By applying this framework, the project can provide clear and actionable recommendations for improving the digital resources, supporting their effective implementation, and ensuring that they meet the needs of learners with disabilities across diverse educational contexts.

To effectively evaluate the digital educational content developed under the Atollo project, a robust and diverse set of data collection methods have been employed. These methods aim to gather feedback, assess usability, and monitor the impact of the digital tools on learners' educational experiences.

The combination of quantitative and qualitative approaches will provide comprehensive insights into the effectiveness and user experience of the content. In addition, new methods such as student assessments and partner questionnaires were integrated to enhance the evaluation framework.

3.1 Quantitative and qualitative surveys

Quantitative and qualitative surveys that are used in this project, are two complementary methodologies used for gathering empirical data within educational research (Morrison, Cohen, et al., 2011). These methodologies provide a framework for understanding complex educational phenomena and yield rich insights into various educational contexts. Our analysis indicates that ontological assumptions beliefs regarding the nature of reality and existence play a crucial role in shaping epistemological assumptions, which pertain to how knowledge is understood and acquired. These epistemological beliefs subsequently influence methodological considerations in research design, leading to critical issues surrounding instrumentation and data collection (Cohen, L., Manion L., & Morrison, K.,

2011:3). By exploring these interconnected layers of inquiry, we can better appreciate the nuanced relationship between the underlying philosophical assumptions and the practical approaches to data collection in educational settings.

Quantitative surveys typically employ structured questionnaires with predefined response options to gather numerical data that can be statistically analysed, enabling generalization and comparison across larger populations. In contrast, qualitative surveys emphasize open-ended responses and participants' subjective experiences, providing rich, contextual insights into attitudes, beliefs, and practices. Combining both approaches allows for a more comprehensive understanding of complex educational phenomena by integrating breadth and depth within the same study design.

The most common method for examining aspects related to students' social and academic learning is the use of rating scales in survey research to quantify assessments. In a survey, respondents are asked to rate statements that reflect a specific attribute or phenomenon. A scale is typically composed of several indicators that relate to the same phenomenon or latent variable, which is described by a theoretical construct.

The advantages of using rating scales are, first, that they provide an efficient tool for summarizing respondents' perceptions. Moreover, the same measurement instrument can be applied multiple times across different points in time, in various contexts, and among diverse respondent groups (such as parents, teachers, and students). In a digital technology project, the same instruments were employed (OECD, 2025).

In this study, a mixed-methods approach was adopted to integrate both quantitative and qualitative data in a complementary way. This design enables researchers to capture the measurable patterns identified through surveys alongside the deeper insights obtained from participants' narratives and reflections.

The combination strengthens the validity and interpretive power of the findings, as quantitative results can be contextualized and enriched through qualitative evidence. Such methodological triangulation is particularly valuable in educational research that seeks to understand both outcomes and experiences within complex learning environments.

3.1.1 Research design

The evaluation framework for Work Package 4 (WP4) is meticulously designed to systematically assess the usability, effectiveness, and integration of digital educational materials tailored for learners with difficulties. Building upon evidence-based methodologies, this framework combines both quantitative and qualitative approaches, ensuring a comprehensive understanding of how these resources affect learning outcomes, engagement, and classroom participation.

The primary objective is to evaluate the effectiveness of the digital tools in improving educational experiences, thus contributing to more inclusive and equitable learning environments. By utilizing a range of data collection methods including online questionnaires, semi-structured interviews, classroom observations, and technical monitoring this framework aims to gather diverse feedback from parents, teachers, school leaders and some of the students.

Each evaluation area is carefully delineated, drawing on relevant academic literature to support the methodologies employed. This structured approach not only adheres to best practices in educational research and evaluation but also guarantees the reliability and actionable insights crucial for ongoing development and refinement of digital educational materials. The evaluation process ensures compliance with GDPR regulations and provides data-driven insights that will inform future adjustments and enhancements.

3.1.2 Sample schools

Teachers, school leaders, parents, and guardians from the selected countries Bulgaria, Croatia and Germany were invited to participate in the pilot phase. Other project partners were also given the opportunity to pilot and recruit additional schools; however, no suitable schools were identified for inclusion in the pilot stage.

A total of 15 schools across three countries Bulgaria, Croatia and Germany participated in the pilot implementation.

- Croatia (HR) had the largest representation, with 11 schools involved.
- Bulgaria (BG) contributed 2 schools.
- Germany (DE) participated with 2 schools.

Together, these institutions involved approximately 120 teachers and 474 students in the pilot activities. Most schools had submitted their letters of agreement, while parental consent forms were still pending or only partially delivered in several cases. This variation indicates differences in administrative readiness across institutions.

Overall, the data reflect a broad and diverse engagement from special education centers and inclusive schools across the participating countries, providing a solid foundation for evaluating the pilot's impact on both teachers and students.

Country	School name	Type of school	Approx. number of students in pilot
Croatia (HR)	Centar za odgoj i obrazovanje Tuškanac	Special school	40
	Škola za odgoj i obrazovanje Pula	Special school	100
	Centar za odgoj i obrazovanje "Šubićevac"	Special school	56
	Centar za odgoj i obrazovanje Velika Gorica	Special school	46
	Centar za odgoj i obrazovanje Rudolf Steiner	Special school	15
	Centar za odgoj i obrazovanje Juraj Bonaći	Special school	36
	Centar za odgoj i obrazovanje Zajezda	Special school	14
	Centar za odgoj i obrazovanje Slava Raškaj Split	Special school	10
	Centar za odgoj i obrazovanje "Vinko Bek"	Special school	5
	Centar za odgoj i obrazovanje Slava Raškaj Zagreb	Special school	10
	Centar za odgoj i obrazovanje Lug	Special school	5
Subtotal Croatia:	**11 schools**	**All special schools**	**≈337 students**
Bulgaria (BG)	140 Ivan Bogorov School	Combined school with primary, secondary and high school	41
	Lozenets Center for Special Educational Support	Special school	26
Subtotal Bulgaria:	**2 schools**	**1 primary/inclusive, 1 special**	**≈67 students**
Germany (DE)	Charles-Hallgarten-Schule – GE-Zweig	Inclusive comprehensive school	50
	IGS Nordend	Inclusive comprehensive school	20
Subtotal Germany:	**2 schools**	**Both inclusive**	**≈70 students**

Table 2. Overview of Participating Pilot Schools

The study involved a total of 15 schools, of which 12 were special schools and 3 were inclusive or primary schools. The total number of students across all schools was approximately 474. The overview provides insight into the diversity of student populations and illustrates how different types of special educational needs are represented across schools. The purpose is to highlight the variety of learners and the range of needs that schools address in their work toward inclusive education.

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These data serve as a contextual basis for understanding the pilot implementation in the project and for comparing how digital learning resources can be adapted to different groups of students with special educational needs.

3.1.3 Sample teachers, guidance, leaders and students

Teachers, school leaders, and parents or guardians from the selected countries Croatia, Bulgaria, and Germany were invited to participate in the pilot phase. Although participation was open to all project partners, no additional schools outside these countries were found suitable for the piloting period.

In total, 15 schools took part in the pilot implementation, engaging approximately 120 teachers and 474 students across the three participating countries.

In Croatia, eleven special education centres participated, representing a strong commitment from schools working with students with diverse learning needs. The Croatian schools contributed the largest share of teachers and students in the pilot.

In Bulgaria, two schools joined one mainstream primary school and one special education centre bringing valuable perspectives from both inclusive and specialized learning environments.

In Germany, two inclusive comprehensive schools participated, each contributing experienced teachers and students accustomed to diverse classroom settings.

Each school designated a principal and a school coordinator or trainer who facilitated communication and local organization of the pilot activities. Most schools provided a signed letter of agreement, while the delivery of parental consent forms varied due to national administrative procedures.

The research design did not aim to collect direct information from students. Instead, the pilot focused on observations and teacher-led reflections as the main sources of data. However, as part of the national implementation, the Ministry of Labour, Pension System, Family and Social Policy in Croatia conducted additional evaluations in selected schools, where children were invited to provide simple feedback using smiley-face indicators. This provided complementary insight into students' engagement and experiences during the pilot activities.

This diverse group of schools, teachers, and students created a rich and representative sample for examining the pilot activities' implementation across different educational and cultural contexts.

No.	Centre / School	City	Date visited	Class / Group	Number of learners	Programme / Accommodations
1	Centre for Upbringing and Education Zajezda	Zajezda	15.05.2025	5th and 6th grade classes	4	Special programme with individualised accommodations
2	Centre for Upbringing and Education Slava Raškaj	Split	27.05.2025	Group: special programme for acquiring competencies in daily living and work	7	Special programme for acquiring competencies in daily living and work
3	Centre for Upbringing and Education Juraj Bonači	Split	28.05.2025	Combined 1st–4th grade classroom with special programme	4	Special programme with individualised approach
4	Centre for Upbringing and Education Šubićevac	Šibenik	28.05.2025	2nd grade	3	Special programme with individualised approach
5	Centre for Upbringing and Education Tuškanac	Zagreb	09.06.2025	8th grade	1	Special programme with individualised approach

Table 3. Visited centres and learner groups (WP4) in Croatia

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Sample teachers in Bulgaria

Data from the beginning of the piloting phase, collected using the first questionnaire was obtained from 13 teachers, however, one did not provide the informative consent. Therefore, 12 teachers' answers were analysed. Teachers have different duration of teaching experience, with most of them working more than ten years (n=5), following the ones who have worked in school four to seven years (n=3), eight to ten years (n=2), and the same number of them (n=1) one to three and less than one year. All teachers work in elementary school, 11 teach children attending lower, and one teach children attending higher classes in school.

Most teachers have already used digital educational contents, 4 often 3 of them sometimes, 4 used rarely, and one never used digital educational content before. Nevertheless, high number of them feel confident to use digital content: 1 completely confident, 7 confident, 1 confident enough and 3 not confident at all.

The main outcome of the first questionnaire was to collect the information about teachers who will use digital content during the pilot phase, and to let them choose the level of the tasks they will use in their teaching. Teachers mostly chose different tasks at the level one (n of tasks=51); following the tasks on level two (n of tasks=17); and tasks at the level three (n of tasks=2).

Data from the second questionnaire was obtained from 24 Bulgarian teachers who reviewed digital content during the pilot study. All Bulgarian teachers reviewed digital content related to mathematics. As expected by the results of the first questionnaire, less teachers reviewed different tasks on a higher level: none of the teachers reviewed tasks on level four, 11 of them chose level three, only one level two and 12 tasks on level one.

Data from the qualitative research methods

Four teachers from 140 School and 5 teachers from 6th Specialized Educational Needs Centre took part in the piloting of the Atollo's learning units in Bulgaria and later provided feedback for the piloting using both online pre- and post-implementation questionnaires and participated in focus-group discussions.

School: 140 school Ivan Bogorov				
No.	**Teacher**	**Years of experience**	**Grades taught**	**Educational background**
1	Teacher 1	More than 30 years	1st–4th grade	Pedagogy and Engineering
2	Teacher 2	More than 30 years	1st–6th grade	Geography and Elementary Pedagogy
3	Teacher 3	More than 25 years	1st–4th grade	Pedagogy and Mathematics
4	Teacher 4	9 years	1st–4th grade	Pedagogy

Table 4. Overview of pilot school 1 with focus group interviews, teaching profiles and digital competence in Croatia

School: 6th "Lozenets" Center for Specialized Educational Support				
No.	**Teacher**	**Years of teaching experience**	**Grades taught**	**Educational background**
1	Teacher 1	6 years	1st–4th grade	Elementary and Pre-school Pedagogy and Pedagogy
2	Teacher 2	2.5 years	1st–4th grade	Special Pedagogy
3	Teacher 3	8 months	6th grade	Special Pedagogy
4	Teacher 4	11 years	1st–4th grade	Special Pedagogy and Ergotherapy
5	Teacher 5	9 years	5th–7th grade	Pre-school Pedagogy and Speech Therapy

Table 5. Overview of pilot school 2 with focus group interviews, teaching profiles and digital competence in Croatia

School	Teacher	Years of teaching experience	Educational background	Self-assessed digital competence
1	T1	≥ 30 years	Pedagogy and Engineering	2–3
1	T2	≥ 30 years	Geography and Elementary Pedagogy	2–3
1	T3	≥ 25 years	Pedagogy and Mathematics	2–3
1	T4	9 years	Pedagogy	2–3
2	T1	6 years	Elementary and Pre-school Pedagogy	4–5
2	T2	2.5 years	Special Pedagogy	4
2	T3	8 months	Special Pedagogy	4–5
2	T4	11 years	Special Pedagogy and Ergotherapy	4–5
2	T5	9 years	Pre-school Pedagogy and Speech Therapy	4–5

Table 6. Teacher characteristics and digital competence

Sample teachers in Croatia

Data from the beginning of the piloting phase, collected using first questionnaire was obtained from 82 teachers, however, one did not provide the informative consent. Therefore, 81 teacher's answers were analysed. Teachers have different duration of teaching experience, with most of them (n=47) working more than 10 years, following the ones who have worked in school from one to three years (n=14), eight to ten years (n=8), less than a year (n=7) and least of them (n=5) have worked in special school from four to seven years. All teachers work in elementary school. From the ones who answered the question at which level do they teach. One teaches children who are at preschool level of education, 26 teach children attending lower, and 22 teach children attending higher classes in school.

Not all teachers answered questions about usage of digital technologies and digital content in education. However, most have already used digital educational contents, 51 of them sometimes, 21 often and 8 rarely. Nevertheless, high number of them feel confident to use digital content: 19 completely confident; 34 confident; 24 confident enough and only one not confident at all.

The main outcome of the first questionnaire was to collect the information about teachers who will use digital content during the pilot phase, and to let them choose the level of the tasks they will use in their teaching. Teachers mostly chose different tasks at the level one (n of tasks=318); following the tasks on level two (n of tasks=200); tasks at the level three (n of tasks=99), and at the level four (n of tasks=72). Data from the second questionnaire was obtained from 325 Croatian teachers who reviewed digital content during the pilot study. Most teachers reviewed digital content related to mathematics (n=263), and others reviewed digital tasks related to information and communication technologies.

As expected by the results of the first questionnaire, less teachers reviewed different tasks on a higher level: same number of teachers chose level four and level three (n=32); level two (n=90) and level one (n=141).

In addition to questionnaires, 18 teachers participated in focus groups in two schools. Both schools educate learners with intellectual and additional disabilities. Teachers' scores on self-assessment of digital skills are between 2,5 and 4. They work in different classroom settings: group of learners with intellectual disabilities and autistic spectrum disorder, classroom teacher in lower classes, math teachers and teachers who support learners included in regular schools.

Pilot school	COO Šubićevac	COO Tuškanac
Participants	13 teachers 6 group teachers learners ID+PSA 5 classroom teachers 2 subject teachers (math and Croatian language)	5 teachers 1 group teacher of learners ID 2 classroom teachers (2. + 3. / 5,6 + 7. g.) 2 teachers - support for inclusion
Digital skills	2,5 - 4	
School	Special school (ID, ASD i MD) Classrooms with basic school program Learners with severe MD	Special school (ID and MD) Classrooms Groups (complex educational needs) „Mobile teams „for inclusion support
Learners' characteristics	Severe multiple disabilities	ID and MD, mild ID (school prep.)
FG duration	1h 55 min	1h 40 min

Table 7. Teacher characteristics and digital competence in pilot schools participating in focus group interviews

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Sample Teachers in Germany

Data from the beginning of the piloting phase, collected using the first questionnaire was obtained from 9 teachers, however. Teachers have different duration of teaching experience, with most of them working eight to ten years (n=4), following the ones who have worked in school for more than ten years (n=3), least of them (n=2) have worked in special school from four to seven years. All teachers work in elementary school, two teach children who are at preschool level of education, 3 teach children attending lower, and 4 teach children attending higher classes in school.

Most teachers have already used digital educational contents, 4 of them sometimes, 3 often, one used rarely, and one never used digital educational content before. Nevertheless, high number of them feel confident to use digital content: 6 confident and 3 confident enough.

The main outcome of the first questionnaire was to collect the information about teachers who will use digital content during pilot phase, and to let them choose the level of the tasks they will use in their teaching. Teachers mostly chose different tasks at the level one (n of tasks=35); following the tasks on level two (n of tasks=34); tasks at the level three (n of tasks=18), and at the level four (n of tasks=8).

Data from the second questionnaire was obtained from 24 German teachers who reviewed digital content during the pilot study. All German teachers reviewed digital content related to mathematics. Even though, regarding the answers from the first questionnaire, most teachers reviewed different tasks the level four (n=12), following level one (n=8), level three (n=3) and only one reviewed the content at level two.

Pilot school	**School number 1** ***Charles Hallgarten Schule***	**School number 2** ***IGS Nordend Schule***
Participants	Focus group 1, school 1: teacher 1= 7 years teacher 2= 18 years teacher 3= 4 years teacher 4= 5 years Focus group 2, school 1: teacher 1= 12 years teacher 2= 15 years teacher 3	
Digital skills	**2,5 - 4**	
School		
Learners' characteristics	Severe multiple disabilities	ID and MD, mild ID (school prep.)
FG duration	47 minutes 4 teachers	40 min 6 teachers
FG 2 duration	35 minutes 4 teachers	

Table 8. Teacher characteristics and digital competence in pilot schools participating in focus group interviews in Germany

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3.1.4 Timeline of pilot phase, focus group interviews and observations

Country / School	Feb 2025	Mar 2025	Apr 2025	May 2025	Jun 2025
Croatia (HR)					
Centar za odgoj i obrazovanje Tuškanac	Pilot	Pilot	Pilot	Prep	Data
Škola za odgoj i obrazovanje Pula	Pilot	Pilot	Pilot	Prep	Data
Centar za odgoj i obrazovanje "Šubićevac"	Pilot	Pilot	Pilot	Prep	Data
Centar za odgoj i obrazovanje Velika Gorica	Pilot	Pilot	Pilot	Prep	Data
Centar za odgoj i obrazovanje Rudolf Steiner	Pilot	Pilot	Pilot	Prep	Data
Centar za odgoj i obrazovanje Juraj Bonaći	Pilot	Pilot	Pilot	Prep	Data
Centar za odgoj i obrazovanje Zajezda	Pilot	Pilot	Pilot	Prep	Data
Centar za odgoj i obrazovanje Slava Raškaj Split	Pilot	Pilot	Pilot	Prep	Data
Centar za odgoj i obrazovanje "Vinko Bek"	Pilot	Pilot	Pilot	Prep	Data
Centar za odgoj i obrazovanje Slava Raškaj Zagreb	Pilot	Pilot	Pilot	Prep	Data
Centar za odgoj i obrazovanje Lug	Pilot	Pilot	Pilot	Prep	Data
Bulgaria (BG)					
140 Ivan Bogorov School	Pilot	Pilot	Pilot	Prep	Data
Lozenets Center for Special Educational Support	Pilot	Pilot	Pilot	Prep	Data
Germany (DE)					
Charles-Hallgarten-Schule – GE-Zweig	Pilot	Pilot	Pilot	Prep	Data (26 Jun)
IGS Nordend	Pilot	Pilot	Pilot	Prep	Data (27 Jun)

Table 9. Timeline of pilot phase, focus group interviews and observations

3.2 Surveys

Conducting Surveys

In this study, surveys were conducted in two phases to capture participants' perspectives both before and after the implementation of a specific digital unit. Survey 1 was administered prior to piloting the digital tool, providing baseline data on users' experiences with digital educational resources, perceived usability, and familiarity with GDPR compliance. Survey 2 was conducted after participants had engaged with the digital resource, allowing for an evaluation of changes in satisfaction, effectiveness, and accessibility.

Questionnaire Design and Target Group

The surveys targeted teachers, parents, and school leaders across three schools. Online questionnaires were chosen as a quantitative method to enable standardized data collection from a broad set of stakeholders.

According to Bryman (2016), this approach is effective for gathering structured data that can be statistically analysed to identify trends and patterns. The questionnaires were tailored for each group to capture relevant experiences: teachers focused on classroom usability and student engagement, parents on support for their child's learning, and school leaders on policy alignment and overall educational goals. Adapted versions using pictorial communication were provided for students with complex needs, ensuring inclusivity and enabling feedback even from those with multiple disabilities (Celizić, 2022).

Survey Focus Areas

The questionnaires included sections on general user experience, satisfaction with digital tools, technical usability, accessibility and inclusivity, GDPR compliance, and suggestions for improvement. Likert-scale questions, binary yes/no items, and open-ended responses were used to collect both quantitative and qualitative insights.

Practical Implementation

Surveys were distributed online using platforms such as Google Forms and IZZI, allowing customization for each stakeholder group and easy export of results for analysis. Project leaders were responsible for questionnaire design, piloting, and validation. Conducting the surveys in two phases provided a comparative view of participants' experiences and helped identify the impact of the digital resource on learning outcomes, usability, and inclusivity.

Relevance to Research

The two-phase survey design allowed the research team to measure changes in perception and effectiveness after real-world use of the digital resource. By combining pre- and post-implementation data, the study could identify strengths and weaknesses of the digital tools, inform iterative improvements, and ensure that the resource met the diverse needs of students, teachers, and other stakeholders.

3.3 Assessment tools

This section presents the assessment tools used to evaluate the piloting of digital resources. Data were collected through teacher and assistant questionnaires, focus group interviews, observation and google data analytics, providing a comprehensive view of teachers' experiences, perceptions of usability, and the impact of the resources on student learning and engagement across different school settings.

Two questionnaires were administered before and after the pilot to both teachers and assistants. All questionnaires, as well as the consent forms and guidelines for conducting the data collection methods, were translated into English, Croatian, Bulgarian, and German to ensure accessibility and consistency across participating schools. The English answers are from Croatian teachers and assistants since the project did not have any pilot schools in England or other English-speaking countries.

3.3.1 Questionnaire 1: Pre-pilot evaluation for teachers and guidance personnel

The first round of questionnaires was administered to teachers prior to the piloting phase of the digital learning materials. This questionnaire aimed to gather preliminary feedback on the perceived usability and effectiveness of the educational content. The questionnaire was embedded as a link within the digital units, ensuring ease of access for participating educators.

A total of over 400 responses were collected, focusing on key aspects such as perceived usefulness, inclusivity, alignment with educational goals, and overall engagement. The Likert-scale items enabled teachers to quantify their experiences, while open-ended questions provided space for more detailed feedback, including reports of issues such as missing audio and suggestions for design improvements.

This feedback will play a crucial role in refining the digital learning resources, ensuring they are better suited to meet the diverse needs of students within inclusive educational environments.

3.3.2 Questionnaire 2: Post- pilot evaluation for teachers and guidance personnel

Following the pilot testing of each digital unit, questionnaire 2 was administered to teachers and guidance personnel. The purpose of this questionnaire was to gather comprehensive feedback on the effectiveness and user experience of the digital educational tools after their implementation in real classroom settings.

This questionnaire encompassed various sections aimed at evaluating specific aspects of each digital resource, including:

1. Effectiveness:
    - To what extent did the digital tool meet learning objectives?
    - How did the resource engage students with varying needs?
2. Usability:
    - Was the tool user-friendly for both educators and students?
    - Were there any technical difficulties encountered during its use?
3. Inclusivity:
    - How inclusive were the digital resources for students with learning difficulties?
    - Did any features pose challenges for these students? If so, please specify.
4. Data Protection and Compliance:
    - Were you confident that the digital tools complied with GDPR requirements?
    - Were parents adequately informed about data privacy policies?
5. Suggestions for Improvement:
    - What modifications would you suggest enhancing the effectiveness and usability of the digital tools?
    - Are there additional features or supports that should be included in future iterations?

The feedback collected will provide invaluable insights for further refining the digital educational content, ensuring it better caters to the needs of all learners.

Combining both quantitative ratings and qualitative comments, questionnaire 2 aimed to deliver a well-rounded picture of the resources' performance in educational environments.

By conducting this post-pilot evaluation, the Atollo project can continually adapt and improve its offerings, fostering an inclusive and effective digital learning experience for students with diverse educational needs.

3.4 Focus group interviews

Focus group interviews are a pivotal method employed in the evaluation framework of the Atollo project, offering a dynamic platform for gathering in-depth qualitative data from diverse stakeholders and three different countries. This methodology facilitates collective discussions among participants, enabling the exploration of shared experiences, perceptions, and challenges related to the digital educational tools developed under the project.

The focus group approach is well suited to this type of research because it facilitates interactive dialogue, enabling participants to respond to, challenge, and elaborate on each other's experiences. This collective dynamic often brings forward perspectives and concerns that would not emerge through individual interviews or surveys (Creswell & Poth, 2018). In studies examining the use of digital tools in education, particularly for learners with cognitive or learning difficulties focus groups are especially valuable, as they can reveal shared challenges, differing interpretations, and context-specific insights that help researchers understand how technology functions in real classroom environments.

Within the context of the Atollo project, focus groups involved a variety of participants, including teachers, guidance personnel, and educational leaders. This diversity will contribute to a richer understanding of the digital resources' effectiveness, usability, and alignment with educational goals.

The discussions facilitated by focus group interviews will not only highlight successes but also identify areas for improvement, ultimately informing the development of more inclusive and effective educational content. These qualitative insights, when analysed alongside quantitative data collected from surveys and other methods, will provide a holistic view of the tools' impact on educational outcomes.

Initial analysis of the collected data revealed strong overall agreement among respondents regarding the materials perceived benefits, though some variations were noted between different countries. Specific insights indicated that teachers tended to select lower levels (L1–L2) for their students, while Levels 3–4 (L3-L4) were more frequently utilized by educators in Germany. Common comments pointed to concerns regarding the excessive text present in aims and instructions, with many educators calling for a division of Level 1 into simpler sub-levels and an increase in the number of exercises provided for each topic.

3.4.1 Procedure for focus group interviews and transcription

Data collection through focus group interviews followed a structured, multi-step procedure to ensure methodological rigor and linguistic accuracy.

Phase 1: Planning and agreements with pilot schools

First, initial contact and agreements were established with all pilot schools that had implemented the digital learning units. In collaboration with school leadership and local contact persons, the research team clarified the purpose of the study, ethical procedures, and the practical framework for the focus group interviews and classroom observations. Formal agreements confirmed the schedule, roles, and expectations for participation.

Phase 2: Development of guidelines and participant selection

Comprehensive guidelines were developed for both focus group interviews and classroom observations. These guidelines were translated into English and German to support bilingual implementation across partner countries. At each school, a local research partner or designated contact person was responsible for identifying and inviting participating teachers, based on their involvement in the pilot and to ensure relevant and diverse perspectives.

Phase 3: On-site data collection

Researchers conducted on-site visits to each participating school. Focus group interviews were held in quiet rooms provided by the schools to minimise disturbances and ensure good audio quality. All interviews were facilitated by a trained moderator who followed a semi-structured interview guide, allowing for both comparability across sites and openness to locally specific experiences. With consent from participants, all interviews were audio recorded.

Phase 4: Transcription and initial quality check

The audio recordings were first processed using automated transcription software, generating draft transcripts. These drafts were then reviewed by German-speaking researchers, who listened to the original recordings while checking the transcripts for completeness, obvious errors, and linguistic accuracy.

Phase 5: Verification and final validation

In the final step, the transcripts underwent a thorough verification process. Researchers ensured that the written transcripts accurately reflected the spoken content, correcting remaining inaccuracies and inconsistencies. Native German-speaking consultants with experience in education and qualitative research conducted a final review. Their task was to validate both the linguistic nuances and the substantive meaning, securing high content quality prior to analysis.

3.4.2 Letter method

Following the completion of focus group interviews and classroom observations, several teachers expressed a desire to share additional reflections and experiences regarding the pilot implementation of digital resources. To facilitate this, the Letter Method was employed as a supplementary data collection approach.

The Letter Method is a qualitative research technique where participants are invited to express their thoughts, feelings, or experiences in writing. This method allows individuals to articulate their perspectives in a considered manner, often leading to deeper insights than might be obtained through verbal communication alone (Stamper et.al., 2020).

In this study, the Letter Method was administered through research assistants stationed at each participating school. These educators distributed the letter descriptions to the teachers, providing them with clear instructions and support as needed. This approach ensured that participants had a familiar point of contact for any inquiries and helped maintain consistency in the data collection process.

The Letter Method proved to be an effective means of gathering rich, reflective data from teachers who might not have otherwise participated in interviews or focus groups. It offered them the opportunity to share their experiences in a thoughtful and private manner, thereby enriching the overall data set and providing valuable insights into the implementation of digital resources in educational settings.

3.5 Classroom observation

Classroom observation serves as a vital method in the evaluation framework, allowing researchers to directly assess how digital educational tools are implemented in real-world settings. By observing interactions between teachers and students, this method captures critical contextual factors that influence the effectiveness and usability of the digital resources. Observations provide insights into engagement levels, instructional strategies, and the overall learning environment, thereby informing future improvements and adaptations of the educational content. This experiential data complements other evaluation methods, creating a holistic understanding of the digital tools' impact on teaching and learning.

3.6 Analysis

The analysis was conducted using a mixed-methods approach, combining qualitative and quantitative techniques. Qualitative data from focus group interviews and classroom observations were analysed thematically to identify recurring patterns, challenges and examples of improvements of the digital resources. Quantitative data from teacher questionnaires and usage logs were examined using descriptive statistics to summarise trends across schools and countries and to support comparison between pilot sites.

3.6.1 Mixed- methods analytical approach

The Atollo project applies a mixed methods design to capture both the measurable and interpretive aspects of teachers' and coordinators' experiences with digital learning units for children with special educational needs. Mixed-methods research allows for a more comprehensive understanding of complex educational phenomena by integrating quantitative and qualitative evidence (Creswell & Plano Clark, 2018).

Quantitative data were collected through structured survey questions embedded in the focus group protocols, designed to generate numerical indicators of teachers perceived usability, accessibility, and pedagogical value of the digital tools. These data were analysed using descriptive statistics (means, standard deviations, and frequency distributions) to identify overall patterns and tendencies (Fetters, Curry, & Creswell, 2013).

Qualitative data were collected through open-ended focus group discussions with teachers, coordinators, and school leaders from Germany, Croatia, and Bulgaria, who participated in the pilot phase of the digital learning units. The qualitative strand aimed to explore participants lived experiences, perceptions of inclusion, and ideas for improving the design and pedagogical implementation of the tools.

The integration of both strands followed a convergent mixed-methods design, in which quantitative and qualitative results were analysed separately and then compared and synthesized to provide complementary insights (Creswell & Plano Clark, 2018).

Focus group method and data collection

Focus group interviews were conducted in each participating country, involving 6–8 participants per group. Each session lasted approximately 60 minutes and was guided by a semi-structured protocol to ensure comparability

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while allowing for in-depth reflection. Focus groups are particularly suitable for educational research because they encourage interaction and co-construction of meaning among participants (Kitzinger, 1995).

All interviews were transcribed verbatim and anonymized before analysis. The transcripts were then imported into NVivo for coding, data management, and cross-country comparison. Quantitative survey responses were collected via online forms integrated with the same session and exported to Statistical Package for the Social Sciences (SPSS) for descriptive analysis.

Data analysis and quantitative strand

The quantitative component focused on frequency counts and mean scores across categories such as:

- Perceived ease of use of digital devices
- Technical functionality and reliability
- Pedagogical relevance for students with special needs
- Training and support needs for teachers

Descriptive statistical analyses (central tendency and dispersion) were conducted to identify recurring patterns, and results were visualized through bar charts and comparative country tables

3.6.2 Content analysis and thematic analysis

The qualitative component followed a two-layer analytical process that combined content analysis and thematic analysis, allowing both structured categorization and interpretive depth (Vaismoradi, Turunen, & Bondas, 2013).

Content analysis

An inductive content analysis (Elo & Kyngäs, 2008) was conducted to identify recurring codes and categories. Researchers from each national team independently coded the data before merging results through a joint coding framework. Codes were first clustered into descriptive categories such as *technical challenges*, *pedagogical adaptation*, *student engagement*, and *institutional support*.

Thematic analysis

Subsequently, a thematic analysis was performed following Braun and Clarke's (2006) six-phase model:

1. Familiarization with the data
2. Generation of initial codes
3. Searching for themes
4. Reviewing themes
5. Defining and naming themes
6. Producing the report

This process allowed researchers to identify overarching cross-national themes, such as:

- Digital inclusion and accessibility
- Pedagogical integration and curriculum alignment
- Professional learning and capacity building
- Sustainability and infrastructure challenges

The use of data analytics tools such as NVivo enabled frequency mapping, co-occurrence analysis, and visualization of thematic networks. This enhanced transparency and traceability in the interpretation process (Bazeley & Jackson, 2019).

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Cross-national comparison and integration

After both strands were analysed, findings were triangulated across countries to detect similarities and context-specific differences. The integration of quantitative summaries and qualitative themes produced a multi-layered understanding of user experiences and needs.

The cross-national synthesis focused on deriving actionable insights for improving the digital learning units in the next development phase (WP5–WP6). These insights will also form the empirical foundation for a forthcoming scientific anthology on digital inclusion and special needs education in Europe.

Analytical model

Phase	Analytical Level	Method/Tool	Outcome
1	Data Preparation	Transcription, anonymization, translation	Clean and standardized data sets
2	Quantitative Analysis	Descriptive statistics (SPSS, Excel)	Aggregated patterns and frequencies
3	Content Analysis	Inductive coding (Elo & Kyngäs, 2008)	Structured categories
4	Thematic Analysis	Braun & Clarke (2006) six-step model	Cross-national themes
5	Data Analytics	NVivo, visualization, co-occurrence mapping	Thematic networks and keyword patterns
6	Integration & Synthesis	Mixed-methods convergence (Creswell & Plano Clark, 2018)	Comprehensive recommendations and improvements

Table 10. Analytical model

Table 10 summarises the analytical model guiding the WP4 study. The process is organised into six interconnected phases that move from technical data preparation to interpretive integration. In phase 1, transcription, anonymization and translation ensure that all material is ethically sound and comparable across countries. Phase 2 applies descriptive statistics (SPSS/Excel) to survey data to identify overall patterns and frequencies in teachers' and learners' responses. In phase 3, qualitative material from open-ended questions and focus groups is subjected to inductive content analysis following Elo and Kyngäs (2008), generating structured categories grounded in the data. Phase 4 builds on this by using Braun and Clarke's (2006) six-step model for thematic analysis to identify cross-national themes that cut across institutions and countries. In phase 5, NVivo-based visualizations and co-occurrence mapping are used to refine these themes into thematic networks and keyword patterns. Finally, phase 6 integrates quantitative and qualitative strands through a mixed-methods convergence approach (Creswell & Plano Clark, 2018), resulting in a synthesized set of evidence-based recommendations for improving the Atollo digital learning environment.

Atollo thematic analysis model

Step	Description	Application in the Atollo project	Expected Output
1. Familiarization with the Data	Researchers read and re-read all transcripts to become deeply familiar with the content, noting first impressions and recurrent ideas.	Each national team (Germany, Croatia, Bulgaria) reviews their focus group transcripts in the original language and in English translation to identify culturally specific insights on digital learning tools.	Annotated transcripts; researcher memos summarizing first impressions.
2. Generating Initial Codes	Systematic coding of meaningful data units relevant to the research question. Codes may capture features such as experiences, attitudes, or perceived challenges.	Codes are generated inductively in NVivo or MAXQDA to capture teachers' and coordinators' experiences regarding accessibility, technical usability, inclusion, and pedagogical integration.	Coding framework (country-specific and cross-country); code frequency tables.
3. Searching for Themes	Grouping codes into potential themes by identifying relationships and overarching patterns.	Codes from all three countries are compared and clustered into broader themes such as *Digital inclusion*, *Professional learning*, *technical barriers*, and *Pedagogical innovation*.	Preliminary thematic map linking codes to emerging themes.
4. Reviewing Themes	Themes are refined by checking their coherence across the dataset. Some may be merged, divided, or discarded.	Cross-country researchers meet (online workshops) to discuss consistency and saturation of themes, ensuring each theme accurately reflects shared and country-specific perspectives.	Validated theme structure across all national datasets.
5. Defining and Naming Themes	Each theme is clearly defined and given a concise, descriptive name that captures its essence.	Themes are defined in Atollo terminology (e.g., *Inclusive Design Strategies*, *Teacher Empowerment*, *Systemic Constraints*) and aligned with project objectives for WP5–WP6 development.	Final list of Atollo-specific cross-national themes with definitions.
6. Producing the Report	The final analytic narrative integrates the themes into a coherent interpretation linked to research questions and practical recommendations.	Synthesized cross-national report highlighting how teachers, coordinators, and leaders experience and suggest improvements to digital learning units for special needs education.	Thematic summary matrix; key recommendations for design improvements; input to the 2026 digital toolkit launch.

Table 11. Thematic analysis based on Braun & Clarke (2006)

Analysis process

The analysis process followed a structured and multi-step approach, combining content analysis and thematic analysis to capture both the manifest and latent meanings of the focus group data. The process began with the development of guidelines for the focus group interviews, which were collaboratively designed to ensure comparability across contexts. These guidelines were then translated into Croatian, German, and Bulgarian, allowing participants to respond in their native languages to support authenticity and comfort of expression.

Following the data collection, each national research partner conducted and transcribed their own focus group interviews. The Norwegian team also utilized Nettskjema (UiO platform) with auto text features to collect additional qualitative input, ensuring data integrity and secure storage. To enable cross-national comparison, all transcripts were translated into English using ChatGPT. The translated versions were subsequently reviewed by the researchers for accuracy and contextual consistency before analysis.

The first stage of the analytical process involved content analysis (Krippendorff, 2019; Schreier, 2012), where researchers systematically identified and coded relevant textual segments corresponding to the research questions. This step allowed for the extraction of meaningful categories and ensured that both frequency and contextual relevance were captured across languages.

Building on this, a thematic analysis was conducted following the six-phase framework proposed by Braun and Clarke (2006). The team familiarized themselves with the data, generated initial codes, and collaboratively

identified patterns that captured shared meanings and variations across national contexts. Themes were refined and defined through iterative team discussions, ensuring both semantic clarity and analytic depth.

The cross-national synthesis resulted in four overarching themes (see Table 12: Thematic Analysis based on Braun & Clarke, 2006), reflecting recurring issues related to digital inclusion, professional learning, pedagogical innovation, and systemic barriers.

From these initial themes, the following country-specific analytical framework was developed:

1. Review of content and accessibility, comprising seven categories:
    1. curricular alignment
    2. interface usability
    3. technical functionality
    4. cognitive load & language
    5. motivational factors
    6. pedagogical adaptability
    7. sensorimotor & visual feedback
2. Classroom organisation and learner diversity, including four categories:
    1. inclusivity in group settings
    2. individualized support needs
    3. behavioural safety concerns
    4. physical environment need
3. Availability of suitable devices and infrastructure, with three categories:
    1. device suitability
    2. equity of access
    3. potential for ai adaptation.

This combined approach of content and thematic analysis allowed for both comparative cross-country interpretation and in-depth contextual understanding of teachers' experiences with digital inclusion and accessibility. The methodological triangulation enhanced the credibility and transferability of the findings, aligning with established practices in qualitative educational research (Nowell et al., 2017).

Theme	Analytical Categories (Criteria)	Description / Analytical Focus
1. Review of Content and Accessibility	1. Curricular Alignment 2. Interface Usability 3. Technical Functionality 4. Cognitive Load & Language 5. Motivational Factors 6. Pedagogical Adaptability 7. Sensorimotor & Visual Feedback	Examines how digital learning materials align with curricular goals and support inclusive design. Focuses on usability, accessibility, and the sensory-cognitive experience of learners with diverse needs.
2. Classroom Organisation and Learner Diversity	1. Inclusivity in Group Settings 2. Individualized Support Needs 3. Behavioural Safety Concerns 4. Physical Environment Needs	Focuses on how classroom dynamics, grouping strategies, and environmental factors affect inclusion and engagement of students with special educational needs.
3. Availability of Suitable Devices and Infrastructure	1. Device Suitability 2. Equity of Access 3. Potential for AI Adaptation	Explores systemic and infrastructural enablers and barriers. Considers digital readiness, device quality, and the potential of AI tools to support accessibility and personalized learning.

Table 12. Thematic analysis based on Braun & Clarke (2006)

3.6.3 Statistical analysis

Statistical analysis is integral to evaluating the performance and effectiveness of the digital educational tools. Utilizing tools like Google Analytics, this process entails collecting and interpreting quantitative data to identify trends, user interactions, and engagement metrics. Statistical methods offer valuable insights into how well the resources are meeting learning objectives and user needs, allowing for evidence-based decision-making.

Regarding the type of this study and data we obtained, we analysed the data with the Statistical Package for the Social Sciences (IBM SPSS v.29) using descriptive statistics, with figures created in Microsoft Excel. Considering the purpose of the data and small number of answers in some variables, results are presented as raw numbers and percentages.

3.7 Reliability and validity

Ensuring reliability and validity is paramount in the evaluation of digital educational tools. Reliability refers to the consistency of measurement, while validity addresses whether the tools accurately assess what they are intended to measure. This section outlines the strategies implemented to enhance both reliability and validity throughout the project, ensuring that the data collected via surveys, interviews, and observations yield trustworthy and meaningful insights. To validate our findings, the partners engaged in a collaborative and transparent process involving both project partners and our own researchers acting as peer reviewers. The validation process included several key steps:

- **Collaborative Review**: Our researchers and partners actively participated in reviewing the evaluation instruments, including the development of questionnaires and survey items. This collaborative effort ensured that all perspectives were taken into account, enhancing the reliability of the measurement tools.
- **Focused Discussions**: Regular discussions among partners facilitated consensus on critical perspectives and terminologies used in the project. This collective understanding was essential in framing the evaluation process and ensuring that all involved were aligned in their approach.
- **Joint Analysis**: Data analysis was conducted in collaboration with partners. This joint effort not only increased the rigor of the analysis but also provided opportunities to cross-verify findings, thus reinforcing validity.
- **Transparency in Process**: All steps taken during the evaluative process were documented and made transparent. This transparency allowed for open dialogue about any potential limitations, such as gaps that might arise during transcription, ensuring that all data handling was appropriate and relevant to the project's objectives.
- **Peer Review Process**: A structured peer review process was employed; wherein external reviewers evaluated our methodologies and findings. For example, renowned experts among the partners, such as associated professor Anne Mette Bjørgen and professor Yvonne Fritze provided feedback based on their independent examination of the project. This scrutiny was invaluable in affirming the robustness of our research approach.

Through these strategies, we aimed to uphold high levels of scientific rigor in our assessment processes, ensuring that our findings on digital educational tools are both reliable and valid. By integrating feedback and insights from various stakeholders, we continue to refine our methodologies, ultimately enhancing the overall quality of our research.

3.8 Ethical consideration

Ethical considerations are a critical component of the evaluation framework, particularly in educational settings involving sensitive populations such as students with learning difficulties. This section highlights the ethical guidelines followed throughout the evaluation process, including the importance of informed consent, data privacy, and compliance with relevant regulations such as GDPR.

Ensuring the integrity and dignity of all participants is paramount, and strategies are in place to protect personal information and promote a safe, respectful evaluation environment. Ethical conduct not only upholds the rights of individuals involved but also strengthens the credibility and integrity of the research outcomes.

3.8.1 Ethical considerations in evaluating digital resources for children with special needs

In evaluating digital resources designed for children with special educational needs, ethical considerations are paramount. Given the vulnerable nature of this population, the Atollo project places a strong emphasis on ensuring that all evaluation activities are conducted with the highest standards of ethical integrity. The primary focus of our evaluation is on gathering feedback from teachers and guidance personnel who play a crucial role in supporting these learners. By engaging directly with the educators who interact with these students on a daily basis, we can obtain valuable insights regarding the functionality and effectiveness of the digital materials.

This commitment to ethical practice includes obtaining informed consent from parents or guardians, ensuring that they are fully aware of the evaluation's purpose and the measures in place to protect their child's privacy and data. Additionally, we recognize the need to tailor our approaches to accommodate the diverse communication styles and abilities of the children involved. This may involve using simplified language in surveys or providing visual aids to enhance participants' understanding and engagement.

As we move forward with the evaluation, we aim to create a safe and supportive environment where all participants feel respected and valued. By adhering to ethical principles, we not only safeguard the rights of the individuals involved but also enhance the credibility and quality of the data collected, ultimately facilitating the development of more effective and inclusive digital educational tools.

3.9 Qualitative document analysis

Qualitative document analysis in the Atollo project was primarily grounded in the materials produced by the participating schools themselves. These include lesson plans, internal guidelines, local adaptations of the digital resources, meeting notes, and short reflective reports written by teachers and school leaders during the pilot phase. Rather than conducting systematic searches across national policy documents or large external databases, the analysis was concentrated on how the pilot schools document their work with Atollo in everyday practice.

By examining some of the locally generated documents, the research team could trace how schools interpret and adapt the digital resources, which pedagogical priorities they emphasise, and how they describe the needs of learners with cognitive and learning difficulties. This provides insight into how the tools are actually taken up in authentic classroom settings, and how teachers translate project intentions into concrete teaching activities, differentiation strategies, and organisational choices.

The document analysis also serves as a bridge between other data sources such as focus group interviews and classroom observations and the written practices of the schools. Comparing what teachers say in interviews with what they record in lesson plans or internal reports could help to identify converging themes, gaps, and potential tensions in their use of Atollo.

In this phase of the project, the use of document analysis has been exploratory and closely tied to the pilot schools' own production of texts, rather than based on a systematic mapping of broader policy or research documents. However, this represents an important potential for the next stage of Atollo: a more structured and comparative

document analysis linking local school documents with national curricula, inclusion policies, and institutional strategies, could further strengthen the evaluation framework and deepen the understanding of how Atollo aligns with, and challenges, existing practices in inclusive digital education.

4. RESULTS

This section presents the findings from the evaluation of the digital educational resources developed under the Atollo project. The results are derived from a comprehensive mixed-methods approach, integrating data collected through various methods, including questionnaires, focus group interviews, classroom observations, technical monitoring, and document analysis.

The insights gathered aim to illuminate the effectiveness, usability, and overall impact of the digital materials, particularly in supporting learners with special educational needs. Key highlights from the data reveal trends in resource usage, engagement levels, and areas requiring improvement.

In analysing the results, emphasis is placed on how these educational tools have performed in real classroom settings, the experiences shared by teachers and students, and the technical performance of the digital content. The findings not only inform recommendations for future iterations of the resources but also serve as a basis for developing a comprehensive inclusive digital education toolkit. Ultimately, the results contribute to advancing the understanding of digital education within diverse learning environments, paving the way for more effective and engaging educational materials.

4.1 Qualitative analysis

The qualitative component of the study focused on capturing teachers' in-depth perspectives on the implementation of the digital learning units. Through focus group interviews and classroom observations, the analysis sought to explore experiences, challenges, and contextual factors that shaped how the resources were used across different school environments.

4.1.1 Focus group interviews in Bulgaria

This analysis presents insights from the focus group interviews conducted in Bulgaria, aiming to gather feedback on the digital resources designed for children with special needs within the Atollo project. The findings will be used to inform the further development of these resources, considering the specific needs and experiences of educators and students.

The focus group interviews revealed various themes related to the usability, accessibility, and effectiveness of these digital tools in the educational landscape. Educators shared their experiences with implementing the resources in the classroom, providing valuable insights that align with similar analyses conducted in Germany and Croatia.

Key areas of feedback include the alignment of digital content with the curriculum, the usability of interfaces for children with differing abilities, and the technical stability of the platforms used. Additionally, the educators

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highlighted the importance of motivation and engagement, as well as the necessity for adjustments to accommodate individual learning profiles.

Through this analysis, we aim to extract actionable recommendations that can facilitate the refinement of digital learning materials, ensuring they are effectively tailored to support children with special needs in Bulgaria.

Review of content and accessibility

In the Bulgarian focus groups, educators noted various accessibility and usability issues that inform the content evaluation and user interface components of the analysis model. The insights gathered are structured into analytical categories:

Nb.	Sub-Dimension	Insight from Bulgarian Focus Groups	Implication for Analysis
1	Curricular Alignment	"The content aligns well with our lesson plans, which is beneficial."	Check for alignment with national or local curriculum
2	Interface Usability	"Some buttons are too small for children with fine motor difficulties."	Assess if design elements follow accessibility principles (WCAG, UDL)
3	Technical Functionality	"The application crashes frequently during use."	Evaluate technical stability and consistency across devices
4	Cognitive Load & Language	"Some tasks are too complex, particularly for children with significant disabilities."	Include readability and language complexity evaluation
5	Motivational Factors	"Engagement varies; some kids are very keen, while others lose interest quickly."	Assess multimedia effectiveness and engagement
6	Pedagogical Adaptability	"Tasks are not suited for all levels; children need tailored approaches."	Analyse scaffolding, progression, and learning objectives
7	Sensorimotor & Visual Feedback	"Visual prompts are often misleading, leading to confusion on tasks."	Evaluate sensory and visual feedback mechanisms

Table 13. Key Insights from Bulgarian Focus Groups

Classroom organisation and learner diversity

Participants from Bulgaria emphasized how different learning needs and behaviours impact usability in the classroom. These findings should be assessed under the focus of classroom integration.

Nb.	Sub-Dimension	Insight from Bulgaria	Implication for Analysis
1	Inclusivity in Group Settings	"Using tablets with the whole class is challenging; some children feel left out."	Analyse how tools support small group or individual instruction
2	Individualized Support Needs	"Children with different disabilities require distinct support approaches."	Identify flexibility for differentiation and IEP alignment
3	Behavioural Safety Concerns	"Some students may react negatively to technical issues, disrupting the class."	Evaluate risks, safety features, and alternative modes of access
4	Physical Environment Needs	"Adjustments to the classroom layout are often necessary."	Assess the tool's dependence on physical environment adaptability

Table 14. Key insights from Bulgarian focus groups

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Availability of suitable devices and infrastructure

Bulgaria's educators faced challenges linked to access to appropriate devices, resulting in concerns about digital equity and readiness in infrastructure.

Nb.	Sub-Dimension	Insight from Bulgaria	Implication for Analysis
1	Device Suitability	"Laptops lack the functionality needed; tablets work better for interactive tasks."	Identify device-specific limitations and design compatibility
2	Equity of Access	"Not all kids have equal access to devices in their homes."	Analyse availability and equity in access across different users
3	Potential for AI Adaptation	"There's potential for personalizing learning experiences with AI technologies."	Explore capacity for intelligent personalization and adaptability

Table 15. Key insights from Bulgarian focus group

Summary of Bulgarian focus group interviews

The analysis introduces targeted insights from Bulgarian educators, enhancing understanding of the usability, accessibility, and infrastructural challenges faced in implementing digital learning tools for students with disabilities in comparison with the previously gathered Croatian insights. This structured model facilitates a detailed evaluation of how digital content meets diverse educational needs across different contexts.

In Bulgaria, two institutions participated in the piloting process of Atollo's learning units: 140 Ivan Bogorov School (inclusive) and the 6th Lozenets Centre for Specialized Educational Support (specialised). Both focus groups and classroom observations revealed significant engagement of teachers with the Atollo digital resources and valuable feedback regarding their accessibility and pedagogical impact.

Teachers reported that students were highly motivated and engaged during lessons that integrated the Atollo materials. In Ivan Bogorov School, the digital tools helped to attract and sustain attention, enhance motivation, and increase confidence in using technology.

While working with the digital units, the teachers expressed their opinion on the usability and suitability of the different tasks for the students - they emphasised that tasks such as memory games and interactive classification exercises were especially effective for learners with mild special educational needs. In "Lozenets" Centre, individualised use of tablets supported the learning process, with about half of the students successfully engaging with the tasks. Teachers noted that students with more complex educational needs benefited from videos and visual cues, while those with higher functional levels responded better to task-based activities.

Common challenges included technical issues (slow loading, occasional interface bugs) and linguistic inconsistencies (English or Croatian subtitles).

The leading role of the teachers remains crucial, starting with the choice of proper level and tasks and continuing with the interpretation of instructions. Teachers highlighted that simplifying the language of instructions, adding more visual examples, and integrating short tutorial clips before exercises would enhance accessibility. As it is hardly possible to have individualized assignments for the level of development and understanding of each concrete student, the interpretation of the assignments and the instructions remain a prerogative of the pedagogues.

The parental role of the parents was discussed predominantly as supportive factor, as the home-based practice and repetitions can sustain the learnt content. However, a limited number of parents are concerned of the too excessive usage of digital technologies and would like to limit the screen time of their children. The learning environment was another important topic in the interviews. The technical difficulties and their dependence on good internet quality, as well as the access to and usage of different devices, led to the recommendation of an offline mobile app. Overall, Bulgarian educators found the Atollo resources user-friendly, inclusive, and aligned with curriculum topics. They valued the visual diversity of characters and images in the materials, describing them

as 'emotionally engaging and motivating for children with SEN'. They also expressed readiness to continue using such tools if the technical reliability and localisation are further improved

The Bulgarian focus group interviews revealed several recurring patterns and contextual factors that require refinement of the original thematic framework. While the six-phase model from Braun and Clarke (2006) remains central, the coding strategy will be adapted to capture both cross-cultural nuances and institutional diversity observed in the two distinct school settings, one mainstream and one specialised.

4.1.1.2 Classroom observation in Bulgaria

Three observations in two very different educational contexts took place in Bulgaria.

In 140 Ivan Bogorov School, the observation took place in a 4th-grade mainstream classroom organised under a co-teaching model, where students were grouped around three tables. One student with special educational needs participated actively with the support of an assistant. An experienced teacher led the process while combining digital learning with real-world activities. The teacher projected the Atollo content on a large interactive screen, while students identified objects both on-screen and in the physical classroom. The SEN student was fully integrated in the activity, often volunteering to go to the screen and demonstrating strong motivation and confidence.

In the 6th "Lozenets" Centre for Specialized Educational Support two observations were conducted in 4th-grade classes focusing on Mathematics "Geometrical shapes" and "Numbers and counting".

Each lesson was individual with a tablet, but in a classroom with other 4-5 SEN students, supported by another special educator. Tablets were used as the main digital devices. Teachers presented the lessons using the Atollo digital content and continuously adapted the language and complexity of instructions to meet individual learners' needs.

Key insights from the Bulgarian observations

Pedagogical Adaptation: Teachers successfully integrated Atollo resources within existing lesson plans, adjusting language, pacing, and support levels to individual learners. Again, the role of the teachers in the interpretation of the assignments and instructions remains the key component for the successful usage of the learning units.

Student Engagement: Students with SEN were highly responsive to visual and interactive tasks. Motivation increased when lessons combined screen activities with real-life manipulation or physical movement. Further, when combining virtual units with real-world exercising, e.g., for special orientation, the educational results improve.

Technical and Accessibility Issues: The main challenges were language inconsistencies and interface sensitivity during touch-based tasks. Offline or simplified modes would be beneficial.

Inclusive Climate: Both settings demonstrated strong inclusion principles collaboration among teachers, peer support, and high student participation rates.

Professional Reflection: Teachers expressed willingness to continue using the Atollo materials, especially if technical stability, translation, and adaptability are enhanced.

In conclusion, the Bulgarian classroom observations confirmed that digital educational tools can meaningfully contribute to inclusive learning, provided they are contextually adapted and supported by teacher mediation. The Atollo resources demonstrated clear potential to strengthen differentiated instruction, multimodal learning, and the active participation of students with special educational needs.

Classroom observation categories in Bulgarian schools

Observation Category	Description	140 Ivan Bogorov School	6th Lozenets Center for Specialized Educational support
1.Introduction of Digital Resource	How does the teacher/guidance counsellor introduce and explain the digital resource to the students?	The students were already aware of the resources. The observation took place at the end of the school year, and it was more of a recap	The students were already aware of the resources. The observation took place at the end of the school year, and it was more of a recap
2.Student Engagement	Are students attentive, interested, and actively participating while using the digital resource? Note observable behaviours (e.g. raising hands, discussing, focused on screen).	All students were engaged and willing to participate, to solve the tasks, and even to show off	The students were focused and were searching the tablets to work on the learning units
3.Student Interaction with Digital Resource	How do students interact with the digital material? Note if they appear confident, need assistance, or struggle with specific elements.	They are open and willing to work. Due to poor fine motor skills, sometimes additional support by a classmate was provided.	The level of development of the fine motor skills affects the usage of the digital units negatively. If a negative issue occurs – freezing, blocking, it may lead to frustration of the learner. Other students in the classroom may want to interact with the tablet.
4.Teacher/Guidance Counsellor Support	How does the teacher/guidance counsellor support students during the use of the digital resource?	The instructions were clear for that school. A video appeared in EN, so the teacher asked one of the students to translate it to the whole class.	Adaptation of the instructions
5.Adaptation of Digital Material	Are any modifications or adjustments made to the material or instructions to accommodate individual students' needs?	The environment was prepared in advance with hidden objects. At the end of the class, all students had to build 3D structures with sticks and clay.	Adaptation of the instructions
6.Pedagogical Strategies Used	What teaching/learning strategies are employed alongside the digital resource? (e.g. group work, individual work, peer support).	A whole-classroom co-teaching environment	Individual work
7.Student Learning Outcomes	Are there observable signs that students achieve intended learning outcomes? (e.g. completing tasks, demonstrating understanding).	The student was able to complete the tasks, on one occasion – supported by a classmate due to limited fine motor abilities	The students managed to complete most of the tasks. Sometimes students wanted to use the tablet for other purposes – playing music, taking selfies, etc. A student did not want to follow the instruction - to draw one straight line but preferred to draw many lines.
8.Technical Issues	Note any technical challenges or issues encountered during use.	A video played in En	Difficulties with sliding
9.Student Feedback (Spontaneous)	Any unsolicited comments or reactions from students regarding the digital resource.	no	no
10.Overall Impression of the Lesson	Observer's brief overall reflection on how the digital resource functioned in this classroom setting.	Overall, the lesson demonstrated excellent integration of Atollo materials into inclusive practice, fostering teamwork, digital literacy, and confidence among both SEN and non-SEN learners.	Students generally responded with enthusiasm, particularly to visual and animated materials. Approximately half of the students completed the digital exercises independently, while others needed guided assistance. Teachers reported that visual cues and short videos sustained attention and helped understanding, even among students with moderate intellectual disabilities.

Table 16. Classroom observation categories in Bulgarian schools

4.1.2 Focus group interviews in Croatia

To ensure comprehensive and comparative analysis of digital resources for students with disabilities, this extension integrates findings from the Croatian focus group interviews into the existing analysis model. The Croatian case provides specific insights into how digital learning content interacts with accessibility, classroom organization, and infrastructural challenges in special education settings.

Review of content and accessibility

The Croatian teachers highlighted a range of accessibility and usability issues that directly inform the content evaluation and user interface components of the analysis model. These can be structured into the following analytical categories:

Nb.	Sub-Dimension	Insight from Croatian Focus Groups	Implication for Analysis
1	Curricular Alignment	"This content is in line with the school curriculum, which is great."	Check alignment with national or local curriculum
2	Interface Usability	"Some boxes are too small…", "No left/right understanding", "Lines should stay for visual feedback"	Assess if design elements follow accessibility principles (WCAG, UDL)
3	Technical Functionality	"Everything suddenly goes off screen", "No saving options", "Tasks don't resize"	Evaluate technical stability and consistency across devices
4	Cognitive Load & Language	"Too difficult for students with severe disabilities", "Language not easy enough"	Include readability and language complexity evaluation
5	Motivational Factors	"Very motivating for some children", "Videos were boring or complicating"	Assess multimedia effectiveness and engagement
6	Pedagogical Adaptability	"Good for repetition, not for learning new knowledge", "No gradual increase in difficulty"	Analyse scaffolding, progression, and learning objectives
7	Sensorimotor & Visual Feedback	"Hard to write numbers", "Tasks should go full screen", "Visual feedback lacking"	Evaluate sensory and visual feedback mechanisms

Table 17. Review of content and accessibility in Croatian schools

Classroom organisation and learner diversity

The Croatian educators pointed out how individualized needs and behavioural profiles affect the usability of digital tools in real classroom settings. These findings should be analysed under a category focused on learning context and classroom integration.

Nb.	Sub-Dimension	Insight from Croatian schools	Implication for Analysis
1	Inclusivity in Group Settings	"Difficult to use with whole classroom… other students neglected"	Analyse how tools support small group or individual instruction
2	Individualized Support Needs	"Students need one-on-one support", "Students have heterogeneous disabilities"	Identify flexibility for differentiation and IEP alignment
3	Behavioural Safety Concerns	"Throws everything", "Puts everything in mouth"	Evaluate risks, safety features, and alternative modes of access
4	Physical Environment Needs	"Environmental adjustments needed"	Assess the tool's dependence on physical environment adaptability

Table 18. Classroom organisation and learner diversity in Croatian schools

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Availability of suitable devices and infrastructure

Teachers noted a major limitation in terms of access to appropriate hardware (e.g., tablets, smartboards), raising issues related to digital equity and infrastructural readiness.

	Sub-Dimension	Insight from Croatia	Implication for Analysis
1	Device Suitability	"Hard to use on laptops… tablets have small screens", "Smartboards would help"	Identify device-specific limitations and design compatibility
2	Equity of Access	"Not all students have tablets or laptops"	Analyse availability and equity in access across different users
3	Potential for AI Adaptation	"Could AI be used to adapt tasks to individual needs?"	Explore capacity for intelligent personalization and adaptability

Table 19. Availability of devices and infrastructure

Classroom observations in Croatia

During the observation of using digital units in classrooms in Croatian schools, observers noticed that lessons were very dynamic, even though learners needed high support from teachers. Therefore, in this approach the teacher also plays a crucial role.

When adequate teacher support was provided, students were engaged, focused and motivated, with good interaction and feedback regarding the digital units and lessons they were learning.

Since many environmental factors can affect the use of digital units, it is important to notice that significant number of students were observed sitting improperly (distorted posture). This posture can impact their independence in using digital units, since it can disturb their hand control and mouse use while solving tasks.

Students with milder difficulties worked successfully on devices at their desks, while those with complex educational needs benefited from using the smart board and additional support from their teachers.

Based on the analysis of the observation findings it can be concluded that teachers in Croatian schools introduced the tasks from digital units by connecting them to the learners' previous knowledge. Only some learners started using digital units with no introduction from the teacher.

Teachers used digital tools in the classroom not only to teach or practice the knowledge but also to encourage work in pairs or groupwork.

During the observations of spontaneous student feedback, observers noticed that learners were motivated and happy while using digital units, therefore it can be concluded that they were very satisfied with the tasks they were solving.

In addition to observation of learners using digital tools in classrooms, observers also took notes about teachers' opinions and feedback. Teachers mostly praise the quality and usefulness of digital units in working with their learners. The analysis of their feedback indicate that they will continue using digital tools even after the pilot study finishes since they recognise how useful it is. Most of them used Level 1 units (math tasks) and some learners used Level 2 tasks, due to their abilities with providing additional support to learners with complex educational needs (multiple disabilities). Teachers, furthermore, gave some additional recommendations for making digital units even better and more useful. Most of them suggested to change the way of moving the pictures on the screen. They proposed clicking on any part of the picture (shape) and then moving it, rather than clicking part of the shape and/or dragging it across the screen. They also noticed some words and/or tasks that were confusing to learners

and provided feedback about it in the questionnaire. Some suggestions were not directly connected to digital tools, but to environmental factors and classroom organisation. They think that it would be helpful if they could use digital units individually with each learner. This way they could adapt units and activity to each learners' individual needs.

Category	Key Points
1. Introduction of digital resource	Teacher introduces tasks, reviews prior knowledge. Proper guidance on using the digital resource. Sometimes no intro → students start independently.
2. Student Engagement	Students interested, focused (in line with their abilities), actively solve tasks. Raise hands, answer, comment, participate. Attention maintained; different level of support needed.
3. Interaction with Digital Resource	Mostly confident in use; frequent users show ease. Some need guidance, especially in task selection, further explanation and clarification.
4. Teacher/Advisor Support	Organizes lesson flow, motivate students. Explains tasks step by step, encourages discussion. Provides feedback, praise, and technical help. Explanation, redirection, positive reinforcement.
5. Adaptation of Digital Material	Simplified instructions & vocabulary. Adjusted pace, volume, and explanations. Individualized approach.
6. Pedagogical Strategies Used	Group work, individual work, pair work. Occasional peer support. Strongly individualized 1:1 approach.
7. Student Learning Out-comes	Visible according to students' abilities. Understanding achieved with varying levels of support. Students mostly connect content and demonstrate success.
8. Technical Issues	Mostly no technical issues. Some slow video loading (possible weak internet). Occasional internet connection problems.
9. Spontaneous Student Feedback	Students - curious, happy, motivated. Positive reactions, satisfaction with tasks. Respond well to praise; solving tasks is fun.

Table 20. Key points from observation of digital units use in Croatian schools

4.1.3 Focus group interviews in Germany

As part of the Atollo project a series of focus group interviews and classroom observations were conducted in Germany in June 2025. This research activity was led by Associate Professor Lillian Gran from University of Inland Norway, and took place in Frankfurt am Main, in close collaboration with local project partners. The German pilot phase represents one of three national case studies within the Atollo project, which collectively aim to identify how digital tools can support inclusive education across diverse educational contexts. The Frankfurt fieldwork was hosted by Goethe University Frankfurt and the City of Frankfurt's Department of Education, with research activities carried out in two pilot schools: IGS Nordend, a large public integrated comprehensive school, and Charles-Hallgarten-Schule, a private special school with a focus on students with learning disabilities.

The research visit was co-organized by Dr. Andriana Stathakopoulou (Goethe University Frankfurt) and Suna Korap (Charles-Hallgarten-Schule), who played a key role in coordinating the recruitment of participants, facilitating access to schools, and ensuring ethical standards were maintained throughout the research process. Research activities were planned and approved in advance, with all instruments translated into German, and all data collection conducted in accordance with GDPR requirements and local institutional guidelines, including data protection support from SIKT (Norway's national research data protection service). Over the course of two days, the research team conducted focus group interviews with three groups of teachers, classroom observations of two digital teaching sessions, and informal dialogues with school leadership. A multilingual set of consent forms, interview guides, and observation templates ensured consistency in data collection across sites. Local research assistants from the schools supported the facilitation of interviews and observations and assisted in communication with parents and staff.

The findings from the Frankfurt fieldwork provide valuable insight into the affordances and limitations of digital resources for inclusive teaching. Teachers at Charles-Hallgarten-Schule reported positive engagement from pupils when using digital tools, particularly in terms of motivation and repetition, but also noted the need for greater adaptability for students with severe cognitive disabilities.Technical and design-related challenges such as interface complexity, insufficient feedback mechanisms, and lack of progression control were also raised.

At IGS Nordend, where teaching occurs in more heterogeneous and inclusive classroom settings, teachers highlighted the difficulty of implementing digital resources that meet a wide range of learning needs simultaneously. Observations and interviews pointed to the importance of adequate classroom equipment, differentiated digital content, and support for individualized instruction in digitally mediated inclusive education.

The Frankfurt study contributes to the broader comparative analysis of how inclusive education is operationalized through digital tools across Norway, Germany, and Croatia.

The preliminary findings underscore the importance of co-designing educational technologies with practitioners, ensuring accessibility, and allowing for pedagogical flexibility.

They also point to a need for iterative development of digital resources that align with curricular goals while accommodating the diversity of learners' cognitive, linguistic, and social needs. This research forms part of the evidence base for the Atollo project's ongoing development of inclusive, scalable, and pedagogically sound digital learning tools aimed at strengthening equitable access to education for all learners, regardless of ability.

Focus group interviews in Germany school 1

Extended Focus Group Analysis: Germany (Charles Hallgarten Schule)

Review of Content and Accessibility

Nb.	Sub-Dimension	Insight from German Focus Groups	Implication for Analysis
1	Curricular Alignment	Some math tasks did not follow German conventions (e.g. unfamiliar division formats and terminology issues)	Verify national curriculum alignment, create country specific variants where needed.
2	Interface Usability	Teachers described screens as visually overloaded; some elements were cut off; drag-and-drop actions were unclear.	Check whether UI follows accessibility principles (WCAG, UDL); simplify layouts and reduce cognitive load.
3	Technical Functionality	Wi-Fi instability, login restrictions, and occasional language mismatches disrupted learning sessions.	Evaluate technical stability; introduce offline mode; simplify login structures.
4	Cognitive Load & Language	Many tasks used story-based instructions that were too linguistically complex for SEN learners.	Assess language complexity; include read-aloud, pictograms, and simplified instructions.
5	Motivational Factors	Gamified elements were motivating, but complex tasks caused frustration; some older students found tasks boring.	Assess motivational design; add micro-feedback, shorter videos, and frustration-reducing features.
6	Pedagogical Adaptability	Teachers requested individual learning paths and progression control for each student.	Analyse adaptive sequencing, scaffolding, and teacher dashboards.
7	Sensorimotor & Visual Feedback	Students struggled with fine motor tasks; some drifted to non-learning apps accidentally.	Evaluate sensorimotor usability; enlarge touch targets; strengthen visual feedback.

Table 21. Content and accessibility school 1 Frankfurt

Classroom Organisation and Learner Diversity

Nb.	Sub-Dimension	Insight from Germany	Implication for Analysis
1	Inclusivity in Group Settings	Whole-class tablet sessions were challenging; several students required 1:1 support.	Analyse how tools support individual and small-group instruction.
2	Individualized Support Needs	Most students with SEN needed continuous adult assistance to navigate tasks.	Identify flexibility for differentiation and support for IEP alignment.
3	Behavioural Safety Concerns	Technical errors triggered emotional reactions in some learners; risk of escalation.	Evaluate error tolerance, safety mechanisms, and calming prompts.
4	Physical Environment Needs	Some classrooms were cluttered or hectic, creating structural barriers for digital use.	Assess dependence on spatial organisation and classroom layout.

Table 22. Organisation and learner diversity school 1 Frankfurt

Availability of Suitable Devices and Infrastructure

Nb.	Sub-Dimension	Insight from Germany	Implication for Analysis
1	Device Suitability	iPads were preferred for SEN learners; laptops were unsuitable for most tasks.	Assess device-specific compatibility and optimise for touch-based interaction.
2	Equity of Access	Many families lacked home devices; learning depended heavily on school-provided technology.	Analyse digital equity concerns and home–school continuity.
3	Potential for AI Adaptation	Teachers expressed interest in avatars and voice-based guidance for enhanced accessibility.	Explore opportunities for adaptive, AI-driven personalization.

Table 23. Availability of devices and infrastructure school 1 Frankfurt

Focus group interviews in Germany school 2

Review of Content and Accessibility

Nb.	Sub-Dimension	Insight from German Focus Groups	Implication for Analysis
1	Curricular Alignment	Visual tasks and quantity-based activities aligned well with German curricula; teachers found alternating pattern tasks and geometry inputs highly relevant.	Prioritise tasks with strong curricular fit; develop clearer progression within topics.
2	Interface Usability	Many students could not understand where to click, drag, or move items; parts of the screen shifted unexpectedly; drag-and-drop actions moved the entire page.	Simplify the UI; enlarge touch targets; reduce page movement; ensure consistent interaction patterns.
3	Technical Functionality	Logging in was difficult; students needed email access; accidental navigation to English versions blocked entry. Weak or unstable school Wi-Fi frequently disrupted sessions.	Introduce child-friendly login codes, icons, or avatar-based IDs; provide an offline mode; ensure language-locking.
4	Cognitive Load & Language	Task texts resembled short stories with multiple steps; students struggled to process narrative content and simultaneously solve the task.	Rewrite instructions using simplified, pictogram-supported language; minimise narrative load; offer multimodal guidance.
5	Motivational Factors	Students who cannot read were unable to continue independently; iPad system-level TTS was available but difficult to activate during lessons.	Integrate built-in read-aloud icons for every task; include pictograms, simplified icons, and audio instructions.

6	Pedagogical Adaptability	Students enjoyed colours, characters, memory games, and geometry tasks. Videos were perceived as too long and abstract.	Shorten videos; incorporate micro-feedback, encouraging messages, and short bursts of activity.
7	Sensorimotor & Visual Feedback	Fine motor tasks were too challenging; children clicked too long and triggered unintended menus.	Simplify interactions to single-tap mechanics; block system-level gestures; provide robust feedback.

Table 24. Content and accessibility school 2 Frankfurt

Classroom Organisation and Learner Diversity

Nb.	Sub-Dimension	Insight from Germany	Implication for Analysis
1	Inclusivity in Group Settings	Whole-class digital sessions were impossible; tasks required 1:1 or 1:2 support due to reading demands and navigation complexity.	Ensure Atollo supports individual pacing and teacher assignment of levels.
2	Individualized Support Needs	Students could not find the correct tasks or levels independently; without guided allocation, they stayed in easy tasks or got lost.	Develop a teacher dashboard with task assignment options and progress tracking.
3	Behavioural Safety Concerns	Autistic students reacted strongly to errors; frustration escalated; some learners threw devices when overwhelmed.	Build error-tolerant task designs, calming prompts, and frustration-reducing feedback loops.
4	Physical Environment Needs	Classroom clutter and movement made digital work harder; students often switched to YouTube or photo apps.	Provide a focus mode or app-locking so children cannot switch to non-learning apps.

Table 25. Organisation and learner diversity school 2 Frankfurt

Availability of Suitable Devices and Infrastructure

Nb.	Sub-Dimension	Insight from Germany	Implication for Analysis
1	Device Suitability	iPads were preferred; laptops unsuitable for SEN learners.	Optimise Atollo specifically for iPad/tablet use.
2	Equity of Access	Parents rarely engaged at home due to login difficulties; students struggled to differentiate learning devices from entertainment.	Introduce simplified at-home login; provide visual cues for educational mode.
3	Potential for AI Adaptation	Teachers suggested voice-responsive avatars and AI guides.	Explore AI-driven avatars, audio prompts, and personalisable assistants.

Table 26. Availability of devices and infrastructure school 2 Frankfurt

Teachers found Atollo motivating and visually appealing, but they also identified some barriers that currently prevent students from working independently. The tasks are often too narrative-heavy, which increases cognitive load, and the lack of a built-in read-aloud function makes it impossible for non-readers to navigate on their own. Drag-and-drop interactions are difficult for many students, and complex login processes create additional obstacles at the start of each session. Teachers stressed the need for a dedicated teacher dashboard to assign tasks and monitor progress, and they reported frequent device switching and distractions when students moved into other apps. Finally, unstable internet connections highlighted the importance of an offline mode so that Atollo can be used reliably in everyday classroom practice.

Classroom observations in Germany school 2

School 1 demonstrates a learning environment exceptionally well positioned for the adoption of inclusive digital resources such as Atollo. Although the Atollo digital tools were not used during the project-week (Projektwoche) lesson, the pedagogical culture strongly aligns with the principles required for effective digital integration. The teacher used the smart board together with the students when they were working on their week project, looking at photos and explaining what they had been doing during their different expeditions in the city.

The presence of multiple assistants, consistent use of individual adaptations, and a leadership team fully trained in special education demonstrate that this school possesses both the competence and organisational structures necessary for meaningful digital inclusion.

Moreover, the emotional climate characterised by warmth, welcome, and relational safety creates optimal conditions for students with diverse needs to engage with new technologies. The varied engagement levels observed highlight the importance of flexible digital design, but they also show that staff are already accustomed to differentiating support. This suggests that digital tools, if adapted for fine motor limitations and distraction-sensitive learners, would enhance rather than disrupt learning. Overall, School 1 provides a strong foundation for further digital innovation. One illustrative example was a boy with significant cognitive difficulties who struggled with much academic learning, but whose teacher knew he was exceptionally skilled with bus and train timetables and therefore deliberately positioned him as the "travel expert" during the city excursions, enabling him to plan routes, guide the group and experience clear mastery and recognition in front of his peers.

School 1 Charles Halgarten demonstrates a warm, structured and relationally strong school culture. Even without digital tools, teachers show high competence in differentiation, emotional support and adapted learning. This positions the school well for successful adoption of digital resources, if materials are short, visually structured and accessible. The school's inclusive ethos forms a stable foundation for future digital innovation.

School 2 IGS Nordend combines high adult support with a physically chaotic learning environment. Despite the noise and clutter, students in the special class were calm and concentrated. However, Atollo's current design does not fully meet their needs. Teachers request shorter texts, shorter videos, delayed task reveal and more motivating, avatar-based feedback. The school is not resistant to digital tools but requires better-aligned materials that match their high-support learners.

Together, the two observations reveal complementary insights: Schule 1 shows the relational and pedagogical foundations needed for inclusive digital learning, while Schule 2 shows the practical barriers and usability challenges faced by high-support learners. Both schools demonstrate strong special-education competence, but they highlight different needs. Schule 1 needs access to suitable digital tools; Schule 2 also needs tools redesigned for accessibility and motivation.

Observation Category	Description	Schule 1 Charles Halgaren	Schule 2 IGS Nordend
1. Introduction of Digital Resource	How does the teacher introduce and explain the digital resource?	No digital resources were used; project-week analogue task.	iPads used without explicit introduction; students transitioned directly after warm-up.
2. Student Engagement	Are students attentive and participating?	Mostly engaged; calm atmosphere; one student avoided task.	Highly calm and focused; one older student expressed boredom.
3. Student Interaction with Digital Resource	How do students interact? Need support?	No digital tools used; several would need fine motor support.	All students required 1:1 adult support for iPad navigation.
4. Teacher/Guidance Counsellor Support	How do teachers support digital use?	High individual support: teacher + assistants scaffolded tasks.	Young teacher led; all 5 students had dedicated adult support.
5. Adaptation of Digital Material	Modifications to meet needs?	No digital material; strong environmental adaptations.	Teachers request shorter videos/texts; delayed task reveal; avatar-based feedback.
6. Pedagogical Strategies Used	Group/individual/peer strategies?	Project-based, relational, small groups.	Warm-up group, then fully individualised 1:1 digital work.
7. Student Learning Outcomes	Signs of understanding?	Most completed tasks: supported students succeeded.	Tasks completed with adult support; one student found material boring.

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8. Technical Issues	Any challenges?	None (no digital use).	Usability issues: wrong word recognition, early task reveal.
9. Student Feedback	Spontaneous comments?	No comments.	One student said she hated the activity; others neutral.
10. Overall Impression	General reflection on digital use.	Warm, inclusive, calm school ready for digital innovation.	Chaotic environment but emotionally stable; digital tools need redesign.

Table 27. School 1 and 2 comparative table observations

Insights from the letter method from teacher in German school

In addition to the structured focus group interviews conducted across partner countries, the German team provided an individual written feedback letter from a teacher who was unable to attend the group session. This approach here referred to as the Letter Method and offers a valuable methodological complement within the Atollo evaluation. Written feedback allows participants to reflect independently, at their own pace, without the social dynamics or time constraints of a group discussion. As a result, it often yields more detailed micro-observations, highly specific examples, and candid critique that might not surface in collective interviews.

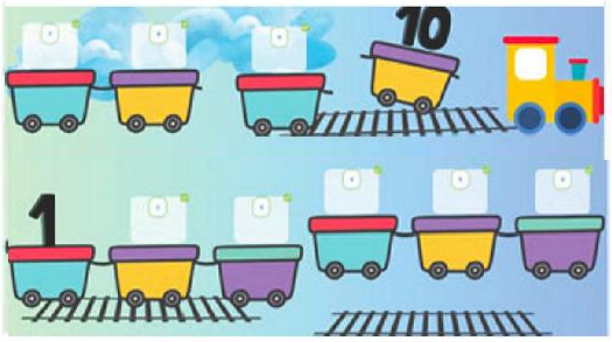
Key insights generated through the letter method:

The content of the letter contributes several important findings to the Atollo analysis:

- Navigation and workflow issues:
- Full screen switching and the need to manually locate the arrow for the next task interrupt concentration and reduce autonomy for students with special educational needs.
- Accessibility gaps:
- The absence of text-to-speech and reliance on written instructions make several tasks unusable for non-readers the exact learner group the resources targets.
- Mismatch between task design and learner profiles:
- Drag-and-drop interactions, small fonts, visually overloaded layouts, and distracting colours create unnecessary barriers for students in FS GE settings.
- Conceptual clarity problems:
- Some tasks do not clearly reflect their intended cognitive purpose (e.g., matching quantities becomes matching pictures; numerical patterns appear arbitrary or visually incoherent).
- Need for simplified interaction models:
- The teacher repeatedly emphasises the value of simple clicking, larger visuals, consistent structure, and guided transitions.

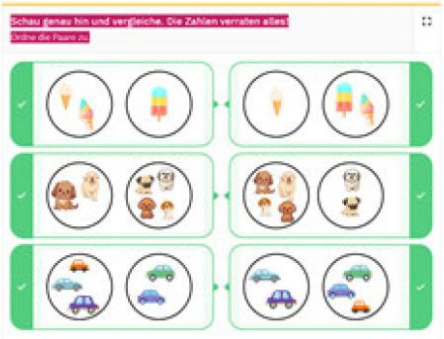
These insights align with but also sharpen the focus group findings from Germany, Croatia, and Bulgaria. While the group discussions highlight broad categories (accessibility, autonomy, scaffolding), the letter provides concrete instances that make these categories actionable in development.

Beispielsweise diese Aufgabe zu den Zahlenfolgen:



Die Zahlen sind nicht einheitlich und zu klein. Zudem ist Zahlenstruktur verwirrend: Warum geht es oben mit 7 los und unten mit 1? Der Wagons sind nicht verbunden. Optisch sind die Farben ablenkend, die Gleise und der Aufbau wirken willkürlich.

Figure 1. Task on numbers



Bei dieser Aufgabe soll es eigentlich darum gehen die Bilder mit den gleichen Mengen zu verbinden. Also soll gezählt werden, aber eigentlich verbinden die SuS nur Eis-Eis, Hund-Hund, Auto-Auto.

Figure 2. Task on equal quantities

4.1.4 Synthesis: Cross-national patterns and divergences

Across both the German and Croatian pilot sites, the data clearly indicate that teachers see digital tools as a powerful driver for inclusion. Teachers in both countries demonstrated high motivation to use digital resources to support learners with diverse needs, and there was broad recognition that gamified and visually rich learning experiences are particularly effective in sustaining engagement. In addition, there was strong consensus that touch-based interfaces are better suited than traditional keyboard and mouse input in special education contexts, especially for learners with fine motor or coordination difficulties.

At the same time, the findings reveal shared structural and pedagogical challenges that limit the inclusive potential of these tools. In both Germany and Croatia, accessibility is constrained by infrastructural barriers, including unstable Wi-Fi connections and a shortage of devices. Teachers also reported that some digital activities generate excessive cognitive and linguistic load for lower-functioning students, which can undermine both motivation and learning outcomes. Moreover, the digital content was often perceived as insufficiently adaptable to different learner profiles, making it difficult to adjust tasks to individual levels, pace, and support needs.

The country-specific insights point to different emphases in how teachers conceptualise quality in digital inclusion. In the German context, teachers placed a particularly strong focus on didactic structure and feedback loops, explicitly noting difficulties in monitoring performance and "seeing how well they did." This aligns with a greater emphasis on student autonomy and self-evaluation, and a clearer demand that digital resources be tightly aligned with national curriculum standards. By contrast, Croatian teachers devoted more attention to physical accessibility and the learning environment, offering detailed feedback on device ergonomics, sensorimotor interaction, and the practical conditions under which digital tools are used in classrooms. Together, these findings suggest that future iterations of the resources must simultaneously strengthen didactic transparency and feedback, enhance adaptability to diverse learner profiles, and address both infrastructural and physical accessibility conditions if they are to fully support inclusive education across partner countries.

4.1.5 Implications for Atollo project WP5–WP6 development

	Development Focus Area	Evidence from Germany + Croatia	Recommended Action
1	Pedagogical Design	Students require tasks with visual clarity, predictable structure, and differentiated language.	Introduce *multi-layered task sets* with increasing scaffolding.
2	Accessibility and Usability	Both groups noted small boxes, cluttered layout, and missing read-aloud functions.	Implement *UDL-compliant interface*, audio buttons, and larger visual zones.
3	Infrastructure Readiness	Teachers report technical instability and lack of devices.	Ensure *offline usability*, *data-light version*, and *school-level support package*.
4	Feedback & Monitoring	Teachers need learner progress overview.	Develop *teacher dashboard* for individual and group tracking.
5	Localization & Cross-Cultural Adaptation	Content not always culturally or linguistically aligned.	Include *national adaptation layer* for math language and curriculum.
6	AI & Adaptive Learning Potential	Both countries open to intelligent adaptation for diverse learning needs.	Explore *AI-driven adaptive difficulty* prototype in next phase.

Table 28. Implications from Germany and Croatia

Integrative summary

This extended analysis confirms that the Atollo learning resource successfully supports engagement and inclusion but requires systematic refinement to address:

- Accessibility gaps, particularly for non-readers and students with motor or cognitive limitations.
- Technical fragility, such as Wi-Fi dependency and limited offline functions.
- Pedagogical adaptation, including individualized learning paths and teacher monitoring capabilities.
- Localization needs, ensuring cultural and curricular accuracy across partner countries.

Integrating both German and Croatian evidence provides a robust analytical foundation for WP5 development sprints and the forthcoming scientific anthology, demonstrating the comparative value of cross-national user feedback for inclusive digital education.

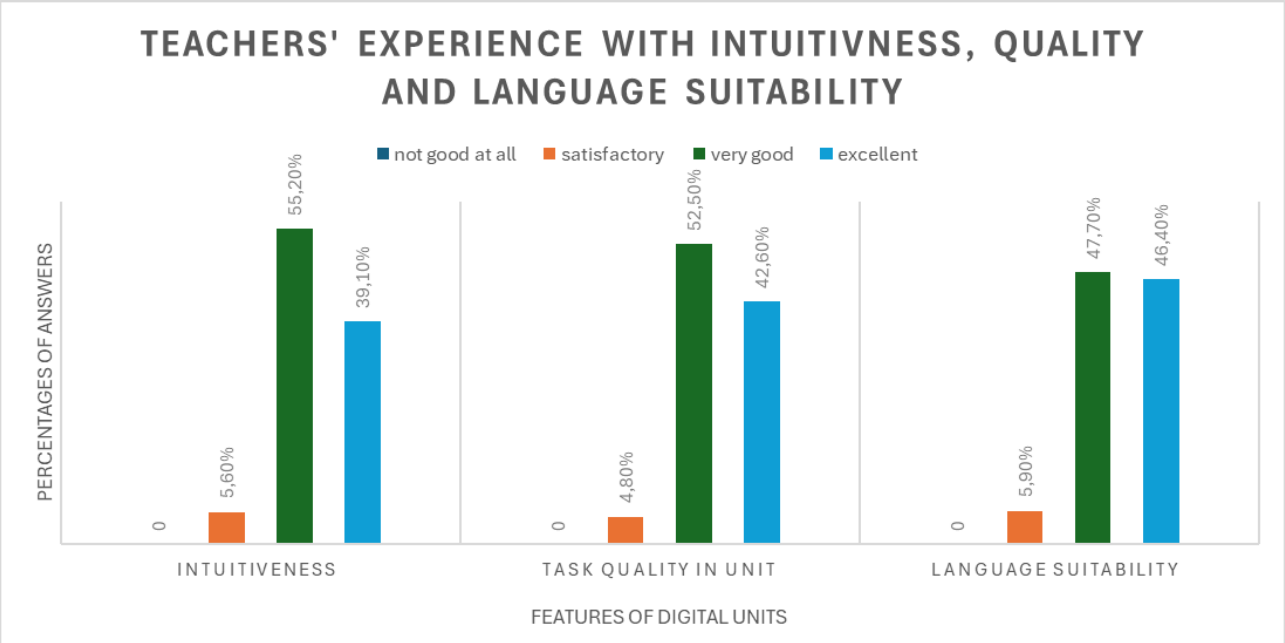
4.2 Quantitative analysis

Using quantitative analysis in the pilot study, we focused on collecting and evaluating measurable and verifiable data about the teachers' experience in using digital content created in the Atollo project. Teachers expressed both the positive and negative experiences with digital content, while implementing it in their teaching. Merged results of teachers from all three countries involved in the pilot study showed that most units are very valuable for use in teaching math and ICT learners with intellectual disabilities. Deeper analysis of the results and comparison among countries indicated that there is no difference in experience of using digital content between teachers from Bulgaria, Germany or Croatia. Nevertheless, due to difference in the number of collected questionnaires, with only 25 participants form Germany and 25 from Bulgaria, we did not use statistical methods to calculate the differences.

4.2.1 Teachers' evaluation of digital unit features

Teachers from all three countries are very satisfied with the intuitiveness of the units (Fig. 1). Most of them (n=352) agree and strongly agree that units they tested were intuitive to navigate. Intuitiveness is a very important feature of the digital content when using it with learners with intellectual disabilities. This feature enables learners to be more independent in using digital tool, which raises self-awareness and self-confidence (Falk & Sansour, 2024). The quality of the tasks in units was also very satisfying according to 355 teachers. Furthermore, most teachers (n=351) also highly rated the translations in each country's native language. (Fig. 3).

Fig. 3 Teachers' experience with intuitiveness, task quality and language suitability of units for learners



Digital units were developed in English, and later translated into Croatian, Bulgarian and German language. Therefore, it is important to analyse language suitability to learners separately for each country. Comparing the percentages of teachers' results from three countries we can conclude that only a minor number of teachers from Croatia and Bulgaria were not satisfied with the language suitability, and a few more teachers from Germany were not completely satisfied. Almost half of the teachers from Croatia agreed and half of them strongly agreed that language was suitable. Bulgarian teachers were also satisfied with translation, with more of them satisfied than very satisfied (Table 29).

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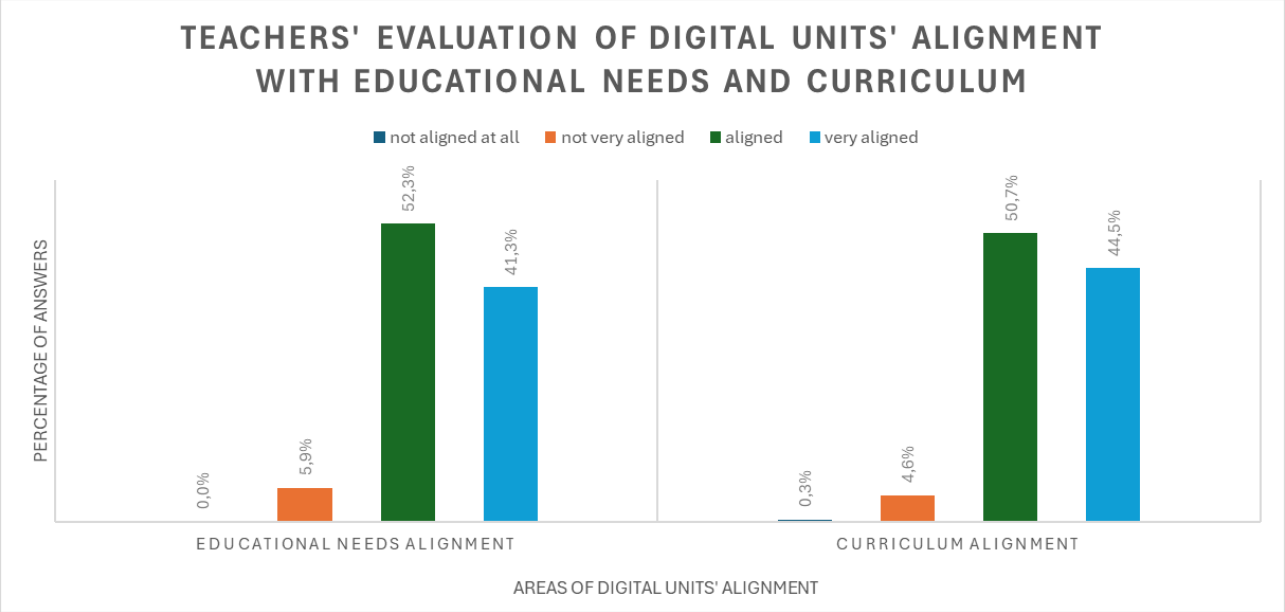
Experience with language suitability	Croatia	Bulgaria	Germany
Not completely satisfied	4.6%	4.2%	25%
Satisfied	46.5%	75%	37.5%
Very Satisfied	48.9%	20.8%	37.5%

Table 29. Teachers' experience with language suitability across countries

Most teachers agreed or strongly agreed that digital content in the reviewed units is in line with educational needs of their learners (n=349) and even more agree that they were in line with the national curriculum (n=355) (Figure 4).

Learners with intellectual disabilities are very heterogenous group with different learning, communication, physical, social abilities and skills. It is, therefore, difficult to make unique teaching materials that would be suitable for every learner. Hence, this teachers' satisfaction with the alignment of the content with learners' educational needs is highly valuable finding from the pilot study. This finding suggests that digital content of developed in Atollo project has broad application to teaching learners with intellectual disabilities.

Fig. 4 Teachers' evaluation of digital units regarding learners' educational needs and curriculum



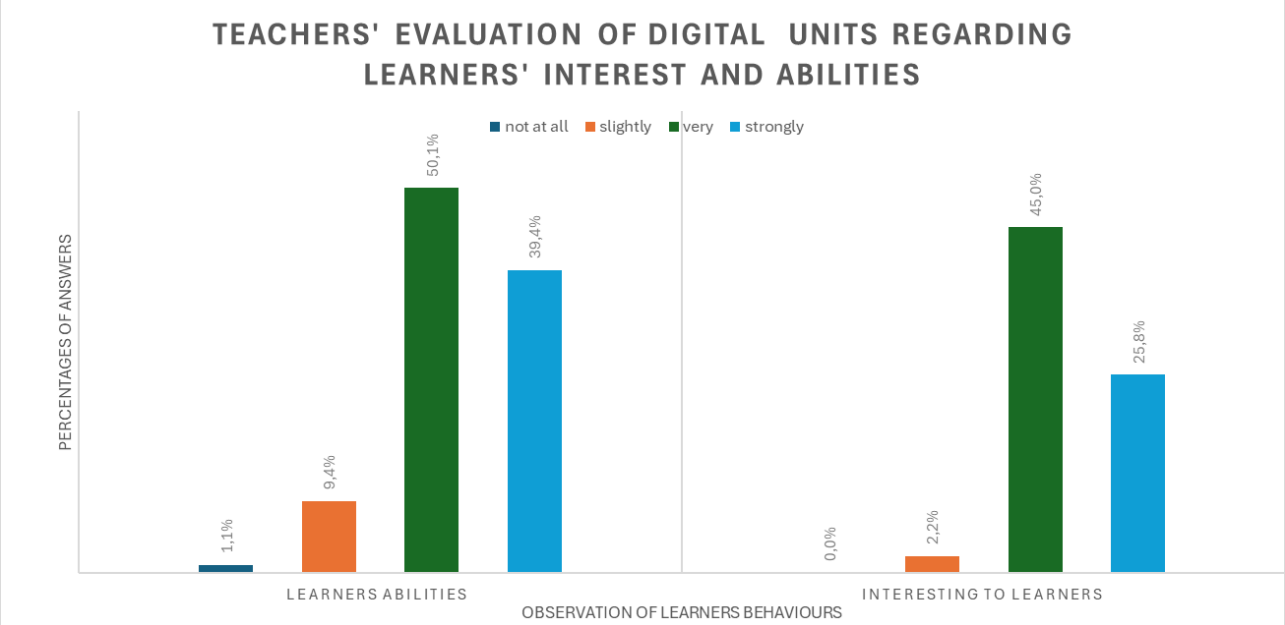
The alignment of digital tasks with national curriculum is important in achieving the outcomes of school curriculum. This enables teachers to use different methods and tasks and to prepare interesting lessons in supporting their learners' education and acquiring learning outcomes. As well as learners with intellectual disabilities differ in their skills and the ways of learning, national curriculums for learners with intellectual disabilities differ in some areas. Therefore, we analysed the percentages of satisfaction with digital units' alignment with curriculum across all three countries (Table 30).

Alignment with national curriculum	Croatia	Bulgaria	Germany
Not aligned at all	0.3%	0	0
Not very aligned	4.3%	4.2%	8.3%
Aligned	46.5%	87.5%	70.8%
Very aligned	48.9%	8.3%	20.8%

Table 30. Teachers' evaluation of digital units' alignment with the national curriculum across countries

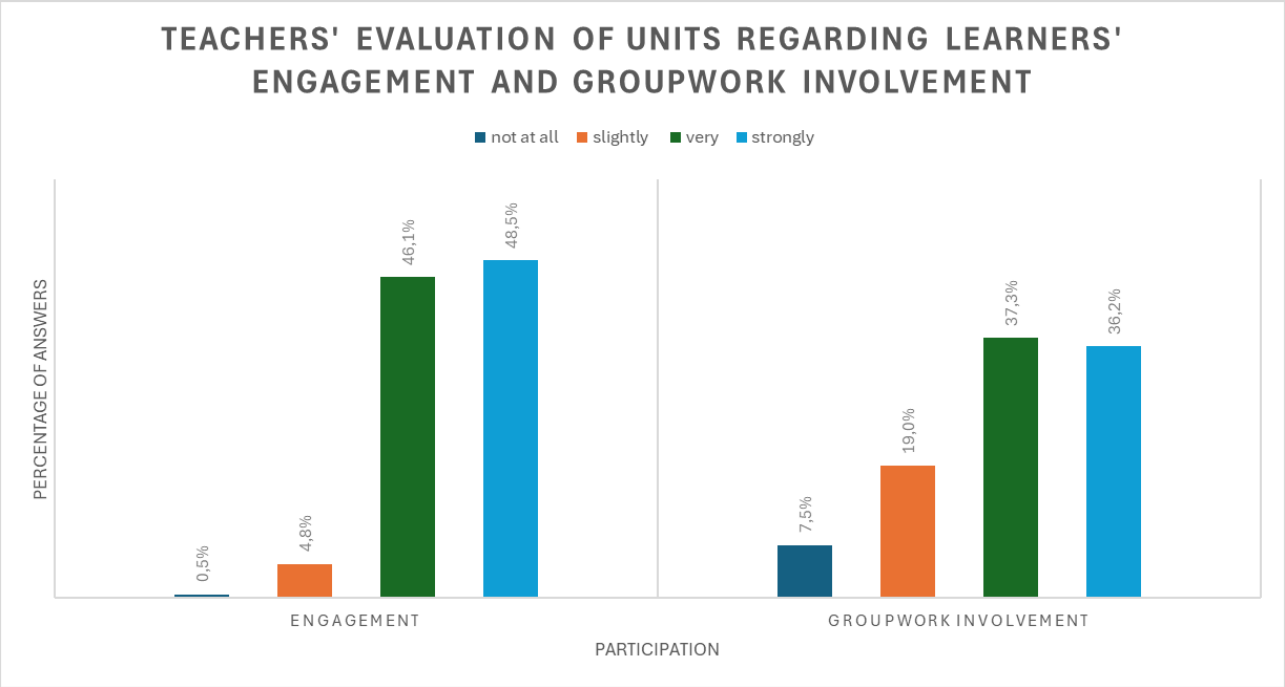
Teachers from all three countries mostly agree that digital content is aligned with the national curriculum of their countries. This result indicates that Atollo digital units can be used for teaching learners with intellectual disabilities in different countries using existing language versions, or when translated to their country language. As mentioned earlier, teachers strive to prepare interesting lessons, suitable to their learners' abilities. Interesting lessons motivate learners to engage more in the learning process (Lei et al., 2024). It was, therefore, important to assess how interesting the content of digital units was for learners, and how suitable to their abilities (Fig. 5). According to teachers' observation of learners' behaviours during implementing digital units in teaching, digital units are very interesting to their learners (n=365). Additionally, they are trongly in accordance with learners' abilities (n=334).

Fig. 5 Teachers' evaluation of digital units regarding learners' interest and abilities



Considering that units were very interesting to learners, it is no surprise that teachers notice how digital content encouraged active participation of learners in learning progress (Fig. 6) Most teachers (n=353) from all three countries observed high level of participation and engagement of their learners into the learning process. Furthermore, as digital units increased the participation of every individual learner, they encouraged involving learners in groupwork with other peers. Even though, some teachers mentioned that they had challenges in implementing the digital content into classroom activities of the whole group, many of them (n=274) were very satisfied how digital content encouraged learner to join the peer learning activities.

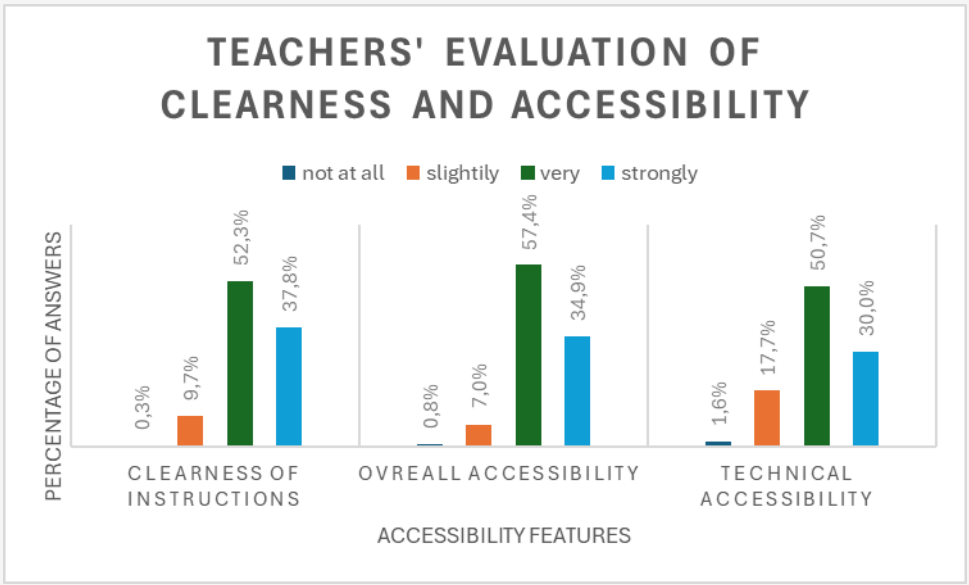
Fig. 6 Teachers' evaluation of units regarding learners' engagement and groupwork involvement



Learning in peer group, cooperative learning, improves learners' self-confidence and better outcome achievement (Jenkins & O'Connor, 2003). However, not all learners with intellectual disability can easily participate in cooperative groups. Therefore, such a high satisfaction of most teachers with the impact of digital units on learners' participation in group learning activities gives exceptional value to Atollo digital units in teaching learners with intellectual disabilities in classroom.

Teachers highlighted the accessibility features of digital units. Most of them were very satisfied overall (n=344), as well as with technical accessibility (n=301). Furthermore, they highly valued the clarity and comprehensibility (n=336) as this is important for learners with intellectual disabilities (Fig. 7).

Fig. 7 Teachers' evaluation of clearness of the instructions, overall and technical accessibility of the unit



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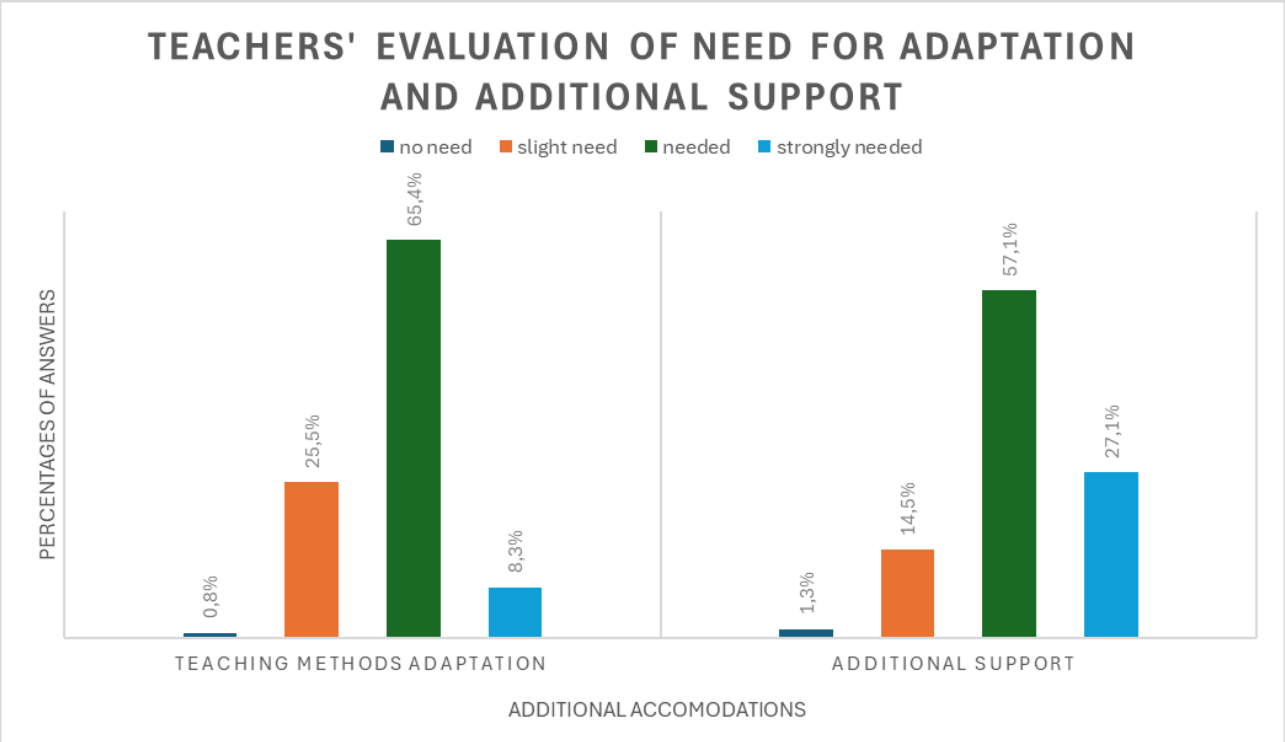
Even though most teachers had very positive opinion about the tasks in units, and they were very satisfied (n=167), satisfied (n=200) how digital content has completed the existing teaching methods, most of them acknowledged that they needed to adapt their teaching methods in order to integrate digital content into the lessons. Furthermore, most of them (n=314) agreed that learners also needed additional support in using digital units (Fig. 8).

Fig. 8 Teachers' evaluation of need for teaching methods' adaptation and additional support for learners when implementing digital content in lessons.



Considering the fact that there is no absolute accommodation that fits all, presented results were expected. As mentioned earlier, learners with intellectual disabilities are a heterogenous group, and it is practically impossible to create content, material, tasks, or digital units that will fit every learner's needs, abilities and skills without any additional adaptation and/or support. Considering that teachers highly rated the alignment of digital units with learners' educational needs, their abilities, and their interest, the need for additional accommodation and support would be something that every teacher was expecting. Additionally, teachers working with learners with intellectual and/or other disabilities commonly to adapt teaching methods, materials and content, as part of their daily teaching routine.

4.2.2 Teachers' comments and suggestions

Detailed analysis of open-ended questions from the second questionnaire gave deeper insight into teachers' experience of using digital units in teaching learners with intellectual disabilities. Most teachers had no additional comments or typed comments such as "no problem" or "everything was fine", which corresponds with the very high rating of all digital units features they reviewed.

Nevertheless, some teachers left comments regarding issues they encountered while using the digital units. Their comments were analysed using thematic analysis. Based on the analysis we extracted three main themes (Table 31).

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In their comments, teachers mainly reported technical issues for tasks at all levels. Most of them reported problems with a) pictures getting out of the screen; b) difficulty in moving parts; c) the screen not adjusting to the size of the monitor and d) some video and audio recordings not starting on the click.

Issue	Level 1	Level 2	Level 3	Level 4
TECHNICAL	-out of the screen -difficulty in moving parts with "drag & drop" -the screen is not adjusting to the size of the monitor -small „box" for inserting answers pictures in memory game are closing to quickly when not paired -some instructions were incorrect -some videos and audios are not starting on the click -tasks are too sensitive to touch	-issue with back to homepage difficulty in moving parts with "drag & drop" -the screen is not adjusting to the size of the monitor -issues with resizing the screen -some videos are not playing -issue with continuing the next part of the task -one drawing task impossible to solve	-task not accepting the correct answer when learner click on "check" -issues with resizing the screen -missing instructions in some tasks -difficulty in moving parts with "drag & drop", the screen is not adjusted to the size of the monitor -in some tasks learner cannot do what expected (colour the square; insert the answer)	-not working (inserting numbers) -some interactive parts are not working correctly -when task is finished, everything goes back to the beginning of the unit not to next task -difficulty in moving parts with "drag & drop"
LANGUAGE	-foreign names are difficult to remember to learners -some words are not used frequently, ergo unfamiliar to learners -some words are too abstract some sentences are too long	-some sentences are too long and not clear enough -some words are not used frequently, ergo unfamiliar to learners -some words are too abstract -speech in one audio is too fast for learners -few spellings issues	-few grammatical and spelling issues	-few typos -some words are too abstract -sometimes word is not depicting the picture
ACCESSABILITY	-too many details -pictures are not realistic enough -eyes in geometrical forms are confusing learners -missing some audio instructions -no possibility to enlarge the font -some pictures are not contrast or clear enough -some answer fields or click buttons are too small	-some videos are too long -some pictures are not realistic enough -some colours are too bright	-time for answer is too short sometimes -missing audio instructions	-one table is not clear enough -missing audio -too many details

Table 31. Thematic analysis reported by teachers across different levels

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Regarding language, most teachers at all levels of the digital units agree that learners tend to be confused with foreign names of the characters. Furthermore, they are confused with some words which are literary expressions used in official languages; however, they are not frequent in everyday use.

Teachers did not have many comments on accessibility features of the digital units, meaning that units are accessible even though many learners needed individual support in solving the task. They mentioned that: a) only some pictures were too small; b) not in a good contrast; c) not clear enough; and d) in some tasks pictures had too many details which can confuse the learner. They also mentioned that audio instructions are needed in all tasks.

Teachers also provided guidelines for improvement needed in reviewed units that are summarized in this report and might contribute to development of digital content in the future. Some of them provided suggestions for improvement even if there is no need for change in existing units but for the future.

Some teachers suggested that in multiple choice questions would be enough to have only two choices for children with severe intellectual disabilities. However, only some of them mentioned that, depending on learners they work with. Therefore, based on the analysis of all the answers, the recommendation would be to leave more choices on multiple choice question and teachers can adjust the difficulty to suit their learners abilities.

Finally, even though some teachers wouldn't change anything, and most of them are very satisfied with the reviewed digital content, some of them provided suggestions. Suggestions might be helpful, not only for improvement of this digital content, but for all digital content that would be created in the future for learners with severe intellectual disabilities.

List of suggestions for digital contents intended to be implemented in teaching learners with severe intellectual disabilities:

Suggestions
Make tasks simpler with less details.
Enable enlarging text font.
Choose real-life pictures and real-life tasks rather than cartoons.
Use easy language and adapt even more for learners with severe intellectual disabilities.
Prolong the time needed for solving tasks.
Move icons by using click not drag.

Table 32. Suggestions from the quantitative analysis

5. SUMMARY AND RECOMMENDATIONS FOR IMPROVEMENT

This cross-country synthesis draws on focus group interviews with teachers from Germany (two schools), Croatia (two schools), and Bulgaria (two schools), observations, data analytics of the digital usage of the resources and piloting in schools in the three countries and reflection and development of digital resources by the partners. Across all sites, teachers described digital units as highly motivating, visually appealing and closely aligned with their national curricula and learners' abilities. They emphasized that the units are free, easily accessible, and usable across a wide age span and a broad range of learning needs across Europe, Australia and Norway for example. Many also highlighted the consistently high quality of the tasks and the strong potential of Atollo to support inclusion, shared pedagogical language, and collaboration among teachers, teaching assistants, and families.

The piloting has not only generated feedback on the digital units themselves, but also stimulated rich discussions about inclusion, special education, and the role of technology in mathematics, language, and the usage of ICT. What the teachers described can be seen as the Atollo supported them in developing a common repertoire for talking about learning goals, differentiation, and assessment, both within schools and across countries. In this sense, the project has functioned as a catalyst for professional dialogue and media-pedagogical development.

At the same time, the data gave insights to areas for further improvement. Most of these concerns are not fundamental flaws, but development opportunities that can make an already strong concept more accessible and sustainable in everyday practice. The recommendations below therefore build on the strengths identified by teachers rather than framing the findings as mere critique. The piloting should be seen as a positive test that shows where small design changes, better infrastructure, and clearer roles for adults around the learner can unlock the full potential of the Atollo ecosystem.

A separate set of challenges relates to organisational and environmental conditions in schools. Unstable Wi-Fi, limited access to devices and smart boards, and a lack of technical support were frequently mentioned. These factors are not caused by Atollo and cannot be solved by this project alone, but they shape what is realistically possible in everyday classrooms. For that reason, the recommendations also point to implementation guidelines for schools and authorities, for example around infrastructure planning, device allocation, and time for collaboration.

Finally, this report should be read as a living document. The present pilot focused primarily on teacher perspectives. A logical next step is to include more systematic classroom observations and child-centred methods, for example, photo-based interviews or guided conversations around screenshots of the units, to capture even better how learners themselves experience Atollo. This will further strengthen the quality of the design decisions in the development cycle.

5.1 Pedagogical design

Teachers in all three countries emphasized that Atollo's pedagogical design is largely in line with the curriculum and with the abilities and educational needs of their learners. They particularly valued the clear learning goals, structured progression, and the way tasks move from concrete to more abstract representations. The units were seen as helpful for creating a shared repertoire of concepts and subject-specific language, and for connecting classroom activities with learners' everyday experiences and the digital worlds they inhabit outside school.

Teachers also highlighted the strong motivational effects of the digital units. Gamified elements, visual feedback, and interactive tasks encouraged participation, especially among learners who usually struggle to engage with traditional materials. The resources supported repetition and practice in ways that did not feel stigmatizing, which is crucial for learners with special educational needs.

At the same time, teachers identified several areas with clear development potential. First, they recommended a stronger one-task-per-screen structure with predictable sequencing to reduce cognitive load, especially for non-readers and learners with attention difficulties. Second, they pointed to the need for more age-differentiated aesthetics and narratives. Teenagers in particular reported feeling infantilised when characters and storylines were clearly designed for younger children. Developing parallel visual and narrative profiles for older learners would make it easier to use Atollo meaningfully across the full age span.

Third, while mathematics has been the primary focus so far, teachers expressed interest in expanding the approach to other subjects and to first-language learning. They also noted that basic operations, such as division, are taught differently across countries and even within national systems. A closer alignment with national and local methods for solving arithmetic problems would help learners transfer what they do in the app directly to what they encounter in their textbooks and examinations.

5.2 Accessibility and usability

Accessibility was a central concern in all focus groups and the quantitative data. On the positive side, teachers agreed that Atollo has the potential to support a wide range of learners, including those with cognitive, linguistic, and motor difficulties. The touch-based interaction on tablets was described as particularly effective, giving learners more direct control and reducing the fine-motor demands that come with trackpads and mice.

However, the pilot showed usability barriers that are relatively straightforward to address. Teachers pointed to small clickable zones, inconsistently available read-aloud functions, and occasionally overstimulating graphics as obstacles for some autistic learners and younger pupils. They recommended implementing a universal text-to-speech control (for example, a persistent "ear" button), larger and more forgiving interaction areas, and an optional "simple visuals" mode with reduced sensory load.

Another recurrent theme was navigation and session continuity. Learners and teachers found it frustrating to log in repeatedly and to have the system forget where a learner left off. A simple algorithm that remembers the user, reopens the last session, and clearly shows which tasks have been completed would significantly strengthen independent work and reduce classroom management demands. The teachers said that the parents also expressed interest in having a way to log in and follow their child's work at home, which could support continuity between school and home.

5.3 Infrastructure readiness

Technical instability and infrastructure constraints were a common backdrop to the piloting. Teachers in Germany, Croatia, and Bulgaria reported unreliable Wi-Fi, device shortages, and limited access to smart boards. In some schools, teachers resorted to tethering their phones to keep lessons running or to rotating a small number of devices between learners. These are organisational and environmental factors rather than shortcomings of the Atollo units themselves, but they decisively shape the user experience.

To mitigate these constraints, teachers strongly recommended offline capability and data-light modes as preconditions for equitable implementation. They also suggested clear guidance for schools on how to plan device allocation, classroom organisation, and technical support when integrating Atollo into regular lessons. Such guidance would help ensure that the strengths of the digital units are not undermined by infrastructure bottlenecks.

5.4 Feedback, monitoring and collaboration

Across all sites, teachers and teaching assistants expressed a desire for better tools to monitor learners' work and to coordinate support. They want to see which tasks learners have completed, how they performed, and where they struggled, to adjust instruction and provide targeted help. The absence of saved results and basic analytics was described as demotivating for both assistants and students.

A unified teacher dashboard that allows for differentiated assignment ("this is your folder; please complete A before B"), progress tracking, and simple reporting would therefore be a major step forward. Teachers also suggested that Atollo could include guidance and micro-courses for teaching assistants, helping them understand how to scaffold tasks, when to step back to allow independent work, and how to communicate with parents about learners' progress. Involving families more systematically, for example through optional home access to selected units, was mentioned as another way to build on the motivational strengths of the platform.

5.5 Localization and cross - cultural adaption

The pilot confirmed the importance of localisation and cultural adaptation. Teachers encountered mathematical terms, division methods, and occasional English phrases that did not fully match national practices or classroom language. While these issues were not pervasive, they were salient enough to affect learners' confidence and teachers' willingness to use certain tasks without modification.

Teachers therefore recommended national adaptation layers that adjust terminology, examples, and sequencing to local curricula and teaching traditions. This includes ensuring that representations of mathematical procedures reflect how they are taught in each country, and that examples and storylines resonate with learners' cultural contexts. The current pilot provides a solid evidence base for making these targeted adjustments in the next iteration.

5.6 Learning environments

The findings also underline that digital tools do not operate in a vacuum. Effective use of Atollo depends on learning environments that promote equality, inclusion, and diversity, and on a shared understanding among teachers, assistants, and school leaders of how the units fit with broader pedagogical strategies. Media pedagogy plays a central role here: when schools allocate time for joint planning, reflection, and experimentation, Atollo becomes a vehicle for developing more inclusive classroom practices.

Methodologically, the present study has focused on adult perspectives. Building on this, future work could include more systematic classroom observations and child-centered research designs. Techniques such as photo-elicitation, drawing, or guided conversations around screenshots of the units can help learners articulate what works, what feels confusing, and what makes them feel seen or infantilised. This is particularly important for teenagers and for learners with complex communication needs, whose experiences are often underrepresented in evaluation studies.

Finally, the pilot has shown that learners with disabilities are as diverse as any other group. A key recommendation is therefore to move away from a "one-size-fits-all" understanding of special educational needs. Instead, Atollo could continue to develop universal design features while also providing options for individualisation in content, visual style, and support levels. In practice, this means recognising that pupils with similar diagnostic labels may require very different kinds of tasks and scaffolds.

5.6.1. Recommendations

Based on these findings, we propose the following recommendations for the next development phase. Each is framed as a way of strengthening what teachers already appreciate about Atollo:

- Teachers should maintain strong alignment with national curricula while teaching with digital educational units made through Atollo project. Units add additional value to learning process and support teachers, they are not supposed to be the only source used in daily teaching. Teacher should use them when appropriate.
- Adopt one-task-per-screen scaffolding with clear, predictable navigation to lower cognitive load and support independent work.
- Introduce age-differentiated visual and narrative profiles, particularly for teenagers, to avoid infantilisation and enhance identification.
- Implement universal text-to-speech, larger interaction areas, and an optional "simple visuals" mode to support diverse sensory and motor needs.
- Enable offline coaching, low-data modes, and persistent logins so that learners can easily resume where they left off.
- Develop a comprehensive teacher dashboard for differentiated assignments, progress monitoring, and simple reporting.
- Provide short training modules and guidance materials for teaching assistants and teachers on how to integrate Atollo into inclusive classrooms.
- Create optional avenues for parental involvement, for example through home access to selected units and simple progress overviews.

5.6.2. Conclusion

The comparative evidence from Germany, Croatia, Bulgaria and all the partner countries confirms that Atollo's digital units are a high-quality, motivating, and inclusive resource with substantial potential across the full age span and a wide range of learner profiles. The strengths highlighted by teachers, curricular alignment, motivational design, and conceptual clarity, provide a solid foundation for further development.

Beyond each national context, Atollo's shared digital environment also enables teachers and guidance across Europe to collaborate more systematically around the learning trajectories of children with special educational needs, developing a common repertoire of concepts, practices, and digital tools.

Addressing the identified development areas around accessibility, infrastructure, localisation, and adult roles will allow the platform to scale more robustly and equitably. The next development cycle should therefore prioritise stability, teacher and assistant support in a toolkit, and adaptive personalisation, while continuing to treat the report and the digital units themselves as living documents that evolve with feedback. In doing so, Atollo can further strengthen its contribution to equality, inclusion, and diversity in European classrooms.

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Appendix 1. Consent form participation in focus group interview

Consent form participation in focus group interview in the Atollo project (English)

Atollo Project
Breaking barriers through education

You are invited to take part in a focus group interview as part of the Atollo project, an Erasmus+ project.

The **Atollo Project** aims to empower learners with difficulties by developing inclusive digital learning materials. Through collaboration between partners from Croatia, Bulgaria, Austria, Germany, Iceland, Norway, Ireland, and Australia — including EdTech companies, universities, schools for children with special educational needs, public authorities, and a non-governmental organization, new digital tools are being analysed and developed. Your feedback will contribute to the further development of these digital learning resources.

Purpose of the Interview

The purpose of the focus group interview is to gather experiences and perspectives from participants related to the testing of the digital learning materials, and how these are used in teaching and learning in schools. The information will be used as a basis for further development of learning resources, guidelines, and reports within the project. In addition, the interview will contribute to developing knowledge about inclusive learning and the use of digital resources in education.

Your Privacy

- The interview will be audio recorded and transcribed.
- All personal data will be treated confidentially.
- Data will be anonymised before being used in reports or presentations.
- Audio recordings will be deleted when the project concludes.

Data Handling

We will only use information about you for the purposes described in this document. Your personal data will be handled confidentially throughout the entire project and in accordance with data protection regulations. Participation is entirely voluntary, and you may withdraw at any time as long as it is still possible to identify you in the data material.

Audio recordings of the interview will be made using a mobile phone [or tablet] and the encrypted application "Nettskjema recorder". The audio file will be sent directly to a secure server for Nettskjema at the University of Oslo (UiO), with whom the Inland Norway University of Applied Sciences has a data processing agreement. The audio files will be transcribed manually or automatically, and then analysed by the researcher. All data handling, analysis, and storage will take place in: OneDrive - Inland Norway University of Applied Sciences/Feide and a OneDrive profile with secure login.

Results from the Project

The results of the research project will be included in scientific articles, books, reports, and other publications or contexts where the research topic is presented. You will not be identifiable in any of these.

Voluntary Participation

Participation is voluntary. You may withdraw from the interview at any time without giving a reason and without any negative consequences for you.

Consent

By signing below, you confirm that:

- You have received information about the project and the interview.
- You understand how your data will be handled.
- You voluntarily consent to participate in the focus group interview.

The Atollo Project Team

You consent to the use of your responses throughout the focus group interview for research and development purposes.

Consent

- [ ] Yes
- [ ] No

Appendix 2. Consent form in classroom observation in the Atollo project

Consent form participation in classroom observation in the Atollo project (German)

Atollo Project
Breaking barriers through education

Einverständniserklärung zur Beobachtung von Unterrichtsaktivitäten und zur Nutzung digitaler Ressourcen

Sie sind eingeladen, an einem Fokusgruppen-Interview im Rahmen des Atollo-Projekts, einem Erasmus+-Projekt, teilzunehmen.
Das Atollo-Projekt hat das Ziel, Lernende mit Beeinträchtigungen zu stärken, indem inklusive digitale Lernmaterialien entwickelt werden.
Durch die Zusammenarbeit von Partnern aus Kroatien, Bulgarien, Österreich, Deutschland, Island, Norwegen, Irland und Australien – darunter EdTech-Unternehmen, Universitäten, Schulen für Kinder mit sonderpädagogischem Förderbedarf, öffentliche Behörden und eine Nichtregierungsorganisation – werden neue digitale Werkzeuge analysiert und entwickelt.
Ihr Feedback wird zur Weiterentwicklung dieser digitalen Lernressourcen beitragen.

Zweck der Unterrichtsbeobachtung
Der Zweck der Unterrichtsbeobachtung besteht darin, systematisch zu dokumentieren, wie die digitalen Lernmaterialien in authentischen schulischen Kontexten eingesetzt werden, und Einblicke zu gewinnen, wie Lehrkräfte, Beratende und Schüler*innen diese Ressourcen im Unterrichts- und Lernalltag nutzen.
Die Beobachtungen sollen Stärken, Herausforderungen und Möglichkeiten zur Verbesserung der digitalen Ressourcen aufzeigen, um die inklusive Bildungspraxis besser zu unterstützen.
Diese Informationen dienen als Grundlage für die Weiterentwicklung der Lernmaterialien, für Umsetzungsempfehlungen und für Projektberichte.

Ihr Datenschutz
- Während der Beobachtung werden keine Audio- oder Videoaufnahmen der Teilnehmenden gemacht, es sei denn, dies wurde im Vorfeld ausdrücklich vereinbart.
- Die Beobachtenden werden schriftliche Notizen anfertigen, die sich auf Unterrichtsaktivitäten, Interaktionen und die Nutzung digitaler Ressourcen konzentrieren. Es werden keine persönlichen oder identifizierbaren Informationen über Schüler*innen oder Mitarbeitende erfasst.
- Alle Beobachtungsnotizen werden anonymisiert, bevor sie in Berichten, Präsentationen oder Veröffentlichungen verwendet werden.
- Alle Beobachtungsdaten werden sicher gespeichert und nach Abschluss des Projekts gelöscht.

Datenverarbeitung
Wir verwenden die im Rahmen der Beobachtungen gesammelten Informationen ausschließlich für die in diesem Dokument beschriebenen Zwecke. Es werden keine personenbezogenen Daten über einzelne Schüler*innen oder Mitarbeitende erhoben. Alle Notizen und Daten werden während des gesamten Projekts vertraulich und gemäß den geltenden Datenschutzbestimmungen behandelt.
Die Teilnahme ist vollkommen freiwillig, und Sie können Ihre Einwilligung jederzeit vor der Anonymisierung der Beobachtungsdaten widerrufen.
Die Beobachtungsnotizen werden sicher auf einem geschützten digitalen Speicher abgelegt, auf den nur das im Projekt beteiligte Forschungsteam Zugriff hat.

Ergebnisse des Projekts
Die Ergebnisse der Unterrichtsbeobachtungen fließen in Forschungsberichte, wissenschaftliche Publikationen und Präsentationen zum Einsatz digitaler Bildungsressourcen in der inklusiven Bildung ein. In den veröffentlichten Ergebnissen oder Materialien werden keine Einzelpersonen, Schulen oder Teilnehmenden identifizierbar sein.

Freiwillige Teilnahme
Die Teilnahme an der Unterrichtsbeobachtung ist freiwillig. Sie können die Teilnahme ohne Angabe von Gründen ablehnen, ohne dass Ihnen oder Ihrer Institution daraus Nachteile entstehen.

Einwilligung
Mit Ihrer Unterschrift bestätigen Sie:
- Sie haben Informationen über das Projekt und die Unterrichtsbeobachtung erhalten.
- Sie verstehen, wie die Beobachtungsdaten verarbeitet werden.
- Sie erklären sich freiwillig mit der Teilnahme an der Unterrichtsbeobachtung einverstanden.

The Atollo Project Team

You consent to the use of your responses throughout Beobachtung for research and development purposes.

Consent

☐ Ich stimme zu:

☐ Ich stimme nicht zu:

Appendix 3. Questionnaire 1 to teachers before piloting

Atollo project: Questionnaire 1 for teachers before the pilot (ENG) Skjema-ID: **484176** Åpent Steng

Vis | Bygg skjema | Kodebok | Innstillinger | Innhent svar | Se resultater

PC | Mobil | Gi oss tilbakemelding om PDF | Last ned som PDF | Sjekk universell utforming i skjemaet

Atollo project: Questionnaire 1 for teachers before the pilot (ENG)

Page 1

Mandatory fields are marked with an asterisk *

Dear Teacher,

Thank you for participating in the pilot of our digital educational units for students with special needs. This questionnaire is designed to gain insight into the participants in this pilot testing and have an overview of the mathematical and digital units that will be tested in the pilot testing.

Please rest assured that this form complies with GDPR requirements. No personally identifiable information will be used. The background information on educators will be used to inform the team and draw general conclusions.

Please complete this form by **28 February 2025.**

Thank you for your time, and participation that contributes to the development of digital learning materials for students with special needs.

The Atollo Project Team

Section 0: Consent

1.You consent to the use of your responses throughout the pilot testing for research and development purposes. No personally identifiable information will be collected or used. *

- ○ Yes
- ○ No

Section 1: Background Information

2.How long is your teaching experience? *

- ○ Less than 1 year
- ○ 1-3 years
- ○ 4-7 years
- ○ 8-10 years
- ○ More than 10 years

3.Which grade levels do you primarily teach? *

- ☐ Preeschool (age 0-6)
- ☐ Lower elementary (age 7-10)
- ☐ Upper elementary (age 11-14)
- ☐ Other

I you answered other please explain

ⓘ This element is only shown when the option "Other" is selected in the question "3.Which grade levels do you primarily teach?"

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4.How often have you used digital tools before this pilot? *

- ○ Frequently
- ○ Ocasionally
- ○ Rarely
- ○ Never

5.How confident are you in integrating digital tools into your teaching practice on a scale from 1 to 4? *

- ○ Not confident at all
- ○ Sligthly confident
- ○ Confident
- ○ Very confident

6.Which of the following areas are included in your formal education or training? (Select all that apply.) *

- ☐ Special education or working with students with special needs
- ☐ Digital tools and technology in education
- ☐ General teacher training (no specific focus on special needs or digital tools)
- ☐ None of the above
- ☐ Other

I you answered other please explain

ⓘ This element is only shown when the option "Other" is selected in the question "6.Which of the following areas are included in your formal education or training? (Select all that apply.)"

Co-funded by the European Union

7.Please choose the mathematical units that fit into your curriculum and lesson plans until the end of the school year and that you will be able to test in the pilot. *

- [ ] Level 1 - Numbers and counting - Similar and different
- [ ] Level 1 - Numbers and counting - More - less – equal
- [ ] Level 1 - Shapes and space - Spatial relations
- [ ] Level 1 - Measurements - Measuring
- [ ] Level 1 - Problem-solving - I solve problems
- [ ] Level 1 - Development of natural numbers - Numbers and sequences
- [ ] Level 1 - Development of natural numbers - Comparing numbers
- [ ] Level 1 - Arithmetic operations - Addition and subtraction
- [ ] Level 1 - Arithmetic operations - Multiplication and division
- [ ] Level 1 - Geometry - Geometric shapes
- [ ] Level 2 - Numbers and counting - Numbers and counting
- [ ] Level 2 - Shapes and space - Spatial relations
- [ ] Level 2 - Shapes and space - Shapes and curves
- [ ] Level 2 - Measurements - Measuring
- [ ] Level 2 - Problem-solving - How to solve a problem?
- [ ] Level 2 - Development of natural numbers - Quantities
- [ ] Level 2 - Development of natural numbers - Numbers
- [ ] Level 2 - Arithmetic operations - Addition and subtraction
- [ ] Level 2 - Arithmetic operations - Multiplication and division
- [ ] Level 2 - Geometry - Spatial relationships
- [ ] Level 3 - Numbers and Counting - Numbers
- [ ] Level 3 - Shapes and Space - Shapes, surface lines and points
- [ ] Level 3 - Measurements - Measurement units
- [ ] Level 3 - Measurements - Measuring
- [ ] Level 3 - Problem-solving - Solving the problems
- [ ] Level 3 - Development of natural numbers - Numbers and relationships
- [ ] Level 3 - Development of natural numbers - Numerical digits and graphic display
- [ ] Level 3 - Arithmetic operations - Addition and subtraction
- [ ] Level 3 - Arithmetic operations - Multiplication and division
- [ ] Level 3 - Geometry - Relationships and shapes in space
- [ ] Level 4 - Numbers and counting - Numbers
- [ ] Level 4 - Shapes and space - Edges, vertices and perimeter
- [ ] Level 4 - Shapes and space - Angles
- [ ] Level 4 - Measurements - Measuring
- [ ] Level 4 - Problem-solving - Solving the problems
- [ ] Level 4 - Development of natural numbers - Concept of numbers
- [ ] Level 4 - Arithmetic operations - Addition and subtraction
- [ ] Level 4 - Arithmetic operations -Multiplication and division
- [ ] Level 4 - Geometry - Relationships and shapes in space
- [ ] Level 4 - Geometry - Features of geometric shapes

8.Please choose two to three additional mathematical units could be tested as part of revision, even if they do not fit into your current lesson plans. *

- [ ] Level 1 - Numbers and counting - Similar and different
- [ ] Level 1 - Numbers and counting - More - less – equal
- [ ] Level 1 - Shapes and space - Spatial relations
- [ ] Level 1 - Measurements - Measuring
- [ ] Level 1 - Problem-solving - I solve problems
- [ ] Level 1 - Development of natural numbers - Numbers and sequences
- [ ] Level 1 - Development of natural numbers - Comparing numbers
- [ ] Level 1 - Arithmetic operations - Addition and subtraction
- [ ] Level 1 - Arithmetic operations - Multiplication and division
- [ ] Level 1 - Geometry - Geometric shapes
- [ ] Level 2 - Numbers and counting - Numbers and counting
- [ ] Level 2 - Shapes and space - Spatial relations
- [ ] Level 2 - Shapes and space - Shapes and curves
- [ ] Level 2 - Measurements - Measuring
- [ ] Level 2 - Problem-solving - How to solve a problem?
- [ ] Level 2 - Development of natural numbers - Quantities
- [ ] Level 2 - Development of natural numbers - Numbers
- [ ] Level 2 - Arithmetic operations - Addition and subtraction
- [ ] Level 2 - Arithmetic operations - Multiplication and division
- [ ] Level 2 - Geometry - Spatial relationships
- [ ] Level 3 - Numbers and Counting - Numbers
- [ ] Level 3 - Shapes and Space - Shapes, surface lines and points
- [ ] Level 3 - Measurements - Measurement units
- [ ] Level 3 - Measurements - Measuring
- [ ] Level 3 - Problem-solving - Solving the problems
- [ ] Level 3 - Development of natural numbers - Numbers and relationships
- [ ] Level 3 - Development of natural numbers - Numerical digits and graphic display
- [ ] Level 3 - Arithmetic operations - Addition and subtraction
- [ ] Level 3 - Arithmetic operations - Multiplication and division
- [ ] Level 3 - Geometry - Relationships and shapes in space
- [ ] Level 4 - Numbers and counting - Numbers
- [ ] Level 4 - Shapes and space - Edges, vertices and perimeter
- [ ] Level 4 - Shapes and space - Angles
- [ ] Level 4 - Measurements - Measuring
- [ ] Level 4 - Problem-solving - Solving the problems
- [ ] Level 4 - Development of natural numbers - Concept of numbers
- [ ] Level 4 - Arithmetic operations - Addition and subtraction
- [ ] Level 4 - Arithmetic operations - Multiplication and division
- [ ] Level 4 - Geometry - Relationships and shapes in space
- [ ] Level 4 - Geometry - Features of geometric shapes

9. Please select at least one additional ICT unit that you could test with your students. *

- [ ] Information acquisition and processing
- [ ] Technology and equipment
- [ ] Digital skills
- [ ] Creation and communication
- [ ] Ethics and security

Appendix 4. Questionnaire 2 teachers after piloting

Atollo project Questionnaire 2. for teachers after end of each unit (ENG)

Page 1

Mandatory fields are marked with an asterisk *

Teacher Feedback Form for Evaluating Digital Units

Dear Teacher,

Thank you for taking part in the pilot of our digital units for students with special education needs. Your feedback and insights are invaluable in refining our digital learning content and ensuring it effectively supports both you and your students.

This evaluation form is designed to gather your immediate feedback **after piloting each** unit in the classroom.**We kindly ask you to complete the form after finishing each digital unit.** The questions focus on your experience with the unit in cooperation with your students, including its content, clarity, and overall effectiveness. Your responses will directly contribute to refining the digital units after pilot testing.

Please rest assured that this form complies with research ethics, data privacy regulations, and GDPR requirements. No personally identifiable information will be collected or used.

Thank you for your time and participation in contributing to the development of digital learning content for children with special needs.

The Atollo Project Team

Section 0: Consent

1.You consent to the use of your responses throughout the pilot testing for research and development purposes. No personality identifiable information will be collected or used. *

- ○ Yes
- ○ No

2.Please select the **digital learning unit** you have completed with your student and would like to provide feedback on, specifying the Level – Module – Unit. *

- Level 1 - Numbers and counting - Similar and different
- Level 1 - Numbers and counting - More - less – equal
- Level 1 - Shapes and space - Spatial relations
- Level 1 - Measurements - Measuring
- Level 1 - Problem-solving - I solve problems
- Level 1 - Development of natural numbers - Numbers and sequences
- Level 1 - Development of natural numbers - Comparing numbers
- Level 1 - Arithmetic operations - Addition and subtraction
- Level 1 - Arithmetic operations - Multiplication and division
- Level 1 - Geometry - Geometric shapes
- Level 2 - Numbers and counting - Numbers and counting
- Level 2 - Shapes and space - Spatial relations
- Level 2 - Shapes and space - Shapes and curves
- Level 2 - Measurements - Measuring
- Level 2 - Problem-solving - How to solve a problem?
- Level 2 - Development of natural numbers - Quantities
- Level 2 - Development of natural numbers - Numbers
- Level 2 - Arithmetic operations - Addition and subtraction
- Level 2 - Arithmetic operations - Multiplication and division
- Level 2 - Geometry - Spatial relationships
- Level 3 - Numbers and Counting - Numbers
- Level 3 - Shapes and Space - Shapes, surface lines and points
- Level 3 - Measurements - Measurement units
- Level 3 - Measurements - Measuring
- Level 3 - Problem-solving - Solving the problems
- Level 3 - Development of natural numbers - Numbers and relationships
- Level 3 - Development of natural numbers - Numerical digits and graphic display
- Level 3 - Arithmetic operations - Addition and subtraction
- Level 3 - Arithmetic operations - Multiplication and division
- Level 3 - Geometry - Relationships and shapes in space
- Level 4 - Numbers and counting - Numbers
- Level 4 - Shapes and space - Edges, vertices and perimeter
- Level 4 - Shapes and space - Angles
- Level 4 - Measurements - Measuring
- Level 4 - Problem-solving - Solving the problems
- Level 4 - Development of natural numbers - Concept of numbers
- Level 4 - Arithmetic operations - Addition and subtraction
- Level 4 - Arithmetic operations -Multiplication and division
- Level 4 - Geometry - Relationships and shapes in space
- Level 4 - Geometry - Features of geometric shapes
- Information acquisition and processing
- Technology and equipment
- Digital skills
- Creation and communication
- Ethics and security

Mandatory fields are marked with an asterisk *

Section 2: Satisfaction with the Digital Unit

9. The overall content of the digital unit was satisfactory. *

- ○ Strongly agree
- ○ Agree
- ○ Disagree
- ○ Strongly disagree

10. The digital unit effectively supported the curriculum's learning objectives. *

- ○ Strongly agree
- ○ Agree
- ○ Disagree
- ○ Strongly disagree

11. The activities in this unit were appropriate for students at this level. *

- ○ Strongly agree
- ○ Agree
- ○ Disagree
- ○ Strongly disagree

12. The instructions for each digital activity were clear and easy to follow. *

- ○ Strongly agree
- ○ Agree
- ○ Disagree
- ○ Strongly disagree

Section 3: Accessibility and Inclusivity

13. The accessibility features in this unit were useful. *

- ○ Strongly agree
- ○ Agree
- ○ Disagree
- ○ Strongly disagree

14. The technical features of the digital activities did not pose challenges for students. *

- ○ Strongly agree
- ○ Agree
- ○ Disagree
- ○ Strongly disagree

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Section 4: Pedagogical Adaptation and Implementation

16.The integration of digital activities into the lesson plan required significant additional preparation and adaptation of teaching methods. *

- ○ Strongly agree
- ○ Agree
- ○ Disagree
- ○ Strongly disagree

17.The digital activities complemented existing teaching practices. *

- ○ Strongly agree
- ○ Agree
- ○ Disagree
- ○ Strongly disagree

18.Additional support was needed for students to use the digital activities. *

- ○ Strongly agree
- ○ Agree
- ○ Disagree
- ○ Strongly disagree

19.The digital activities in this unit encouraged active participation from students with special needs. *

- ○ Strongly agree
- ○ Agree
- ○ Disagree
- ○ Strongly disagree

20.The digital activities were used to engage students in collaborative or group learning activities. *

- ○ Strongly agree
- ○ Agree
- ○ Disagree
- ○ Strongly disagree

21.Please describe any specific pedagogical challenges you encountered, while using the digital activities in this unit, if any.

Section 5: Suggestions for Improvement

22. Please provide any suggestions for improving the effectiveness of the digital unit.

Appendix 5. Summary and recommendations

#	Development Focus Area	Evidence from Germany + Croatia + Bulgaria	Recommended Action
1	Pedagogical Design	Germany: Need for one-task-per-screen, stronger scaffolding, and more repetition; multi-item pages/scrolling disrupted focus. Croatia: 20-min videos too long; teachers split into example → guided → paper tasks; mixed-ability classes require two parallel difficulty levels; smartboard works well for group, tablets for 1:1; some units bundle tasks that are alternately too easy/too hard within the same level. Bulgaria: Mixed-ability groups need simplified and standard tracks; some task types (drawing, complex figures) stalled learners; teachers favour clear example before task.	Introduce multi-layered task sets: concise example → guided step → independent item; one-task-per-screen flow; provide dual tracks (simplified/standard) per lesson and adjustable repetition/difficulty ceilings.
2	Accessibility & Usability	Germany: Missing read-aloud blocked non-readers; overstimulating visuals for some autistic learners; tablets preferred over mouse/trackpad. Croatia: Hit-areas too small; hard to stay in full-screen; content sometimes over-detailed/too colourful; need a persistent "speaker/ear" button; text-to-speech absent or inconsistent; tablet touch far better than mouse; tasks should fit entirely on screen. Bulgaria: Sliding/drag tasks difficult on some devices; translations partially in English; occasional lag.	Ship a UDL-compliant UI: global TTS on every instruction, larger touch targets, simple-visuals mode, strict fit-to-screen layout, tablet-first interactions; reduce reliance on drag where device performance is weak.
3	Infrastructure Readiness	Germany: Unreliable Wi-Fi; device/account limits; offline repeatedly requested. Croatia: Device shortages; many classrooms only had laptops; smartboards limited or absent; teachers report technical constraints block group work. Bulgaria: Occasional program lag; external screens failed to load some lessons.	Provide offline usability (local caching + sync), a data-light mode, and a school deployment package (bulk enrolment, generous concurrent sessions, simple device management).
4	Feedback & Monitoring	Germany: Need per-student assignment ("folders"), simple progress views. Croatia: Progress not saved; exiting loses work → demotivating; teachers request student portfolio/memory to compare growth over time. Bulgaria: Individual work common; teachers need quick visibility to who completed what.	Build a teacher dashboard: assign to individuals/groups, show live completion/accuracy/time-on-task, persist results (resume were left off), and export reports.
5	Localization & Cross-Cultural Adaptation	Germany: Some math terminology/methods unfamiliar. Croatia: Teachers requested clearer Croatian UI text and fully translated audio. Bulgaria: English audio/text appeared in places; teachers want simple, localized instructions/examples; spatial terms challenging without visuals.	Add a national adaptation layer (terminology, currency, measurement units, examples) and guarantee full translation of UI/audio; include visual exemplars for spatial language.
6	AI & Adaptive Learning Potential	Germany: Openness to intelligent differentiation if teacher control is retained. Croatia: Classes show wide variance within a single level → strong case for adaptive pacing/selection; teachers explicitly want to personalise paths. Bulgaria: Preference for individual mode for SEN while keeping a class-level path for peers → good fit for explainable adaptive tracks.	Prototype explainable adaptive difficulty with teacher-set guardrails (content ranges, repetition minimums) and always-visible override; support parallel (SEN/standard) modes on the same concept.

Atollo Project

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