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AN EXAMINATION OF SCIENCE TEACHERS' METHODS FOR SELECTING AND IMPLEMENTING LEARNING OUTCOMES FOR STUDENTS WITH SPECIAL NEEDS

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Abstract:
The present research examines how science teachers choose and implement instructional objectives for their students with special needs within the broader practice of inclusive education. Developing our work in science education from the lens of policy and frameworks that exist right now in education (which is partly a goal for all educators to make scientific knowledge accessible), we are addressing all of the pedagogical and structural barriers that exist for students with disabilities, so they also have equitable access to participation in science education. The methodology used was qualitative field-based research based on interviews with 59 science teachers from across Turkey. The results indicate that teachers largely referenced formal sources such as guidelines from the Ministry of Education, RAM reports (Counseling and Research Centers), and IEPs (Individualized Education Plans), when selecting appropriate learning objectives. Regarding the pedagogical practices, the participants reported relying mainly on physical learning materials, multisensory approaches, technology or more eco-friendly equipment and/or tools, as well as modified worksheets or educational materials. Consequently, our research concludes by highlighting the need for formal professional development on a longer-term basis in addition to institutional support towards more inclusive and effective practices related to science education.

Keywords: inclusive education, science instruction, students with special needs, Individualized Education Plans (IEPs)

1. Introduction

In recent years, significant progress has been achieved both nationally and internationally in securing the educational rights of students with special needs. Key international documents, such as UNESCO's *Salamanca Statement* (1994) and the *United Nations Convention on the Rights of Persons with Disabilities* (2008), emphasize that inclusive

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education is a fundamental human right, underlining the imperative for all students to access quality educational opportunities. Within this framework, it becomes essential to develop educational practices—particularly in core subjects such as science—that support the academic and social development of students with special needs (AAAS, 1993; European Commission, 2007).

In Turkey, students with special education needs are referred to inclusive classrooms, special education classes, or specialized schools based on evaluations conducted by Guidance and Research Centers (RAM) (MEB, 2018a). However, in practice, several challenges hinder the effectiveness of inclusive education. Notably, a lack of teacher knowledge regarding different types of disabilities and inadequate access to appropriate instructional materials constitute major barriers (Yazıcıoğlu, Tansel & Kızılaslan, 2021; Cavkaytar, 2013). Additionally, overcrowded curricula and limited instructional time are frequently reported as key obstacles by teachers. Villanueva and colleagues (2012) advocate for the adoption of a "big ideas" approach in science education, which emphasizes core concepts and simplifies curriculum content, thereby enabling students to achieve a deeper and more meaningful understanding.

Moreover, it has been noted that traditional assessment practices often fail to accurately reflect the performance of students with special needs. Therefore, alternative assessment strategies—such as oral presentations, project-based learning, and performance evaluations—have been recommended (Salend, 1998; Mastropieri & Scruggs, 2016). Instructional processes for students with special needs must be tailored to individual differences and supported through adaptive teaching strategies and materials (Cavkaytar, 2013; MEB, 2007).

Particularly for students with visual impairments, the abstract and highly visual nature of science content presents considerable learning challenges (Bülbül, 2013; Aktaş & Argün, 2021). Consequently, teachers are compelled to employ multisensory instructional methods—such as tactile materials, Braille resources, and audio descriptions—to facilitate access to content (Kızılaslan & Sözbilir, 2022; Ünlü, Pehlivan & Tarhan, 2010). Accessibility of instructional materials thus plays a critical role in the success of inclusive education. For students with visual impairments, tools like tactile graphics, auditory simulations, and three-dimensional models have proven effective in concretizing abstract scientific concepts (Hill, 2013; Zorluoğlu & Kızılaslan, 2019). Similarly, scaffolded instruction and activities supported by concrete examples are recommended for students with intellectual disabilities to make learning more accessible (Çapraz, 2016; Demir, 2008).

In this context, a detailed investigation into how science teachers identify and implement learning outcomes for students with special needs is of paramount importance for advancing inclusive education. Identifying teachers' needs, supporting them through in-service training, and fostering interdisciplinary collaboration can make a significant contribution to the success of students with special needs in science education (Sözbilir, Kutu & Yasar, 2012; Sellioğ & Sürmeli, 2025).

This study aims to analyze the processes through which science teachers select and apply learning outcomes tailored to students with special needs, thereby contributing meaningfully to the development of inclusive science education. The findings are expected to serve as a valuable guide for both policymakers and educators, helping to enhance the quality of science learning experiences for students with special needs.

In Turkey and across the globe, developments in the education of individuals with special needs have accelerated due to growing public awareness, strengthened legal frameworks, and the influence of inclusive education policies (Mete, 2016; UNESCO, 1994). Ensuring access to quality education in fundamental disciplines such as science not only supports students' academic achievements but also fosters their social and personal development (AAAS, 1993; European Commission, 2007). However, for such access to be effectively realized, the challenges teachers face in selecting and implementing appropriate learning outcomes must be addressed. Special education is defined as a systematic process based on individual differences and carried out through adapted programs (MEB, 2007; Cavkaytar, 2013). Accordingly, research into how science teachers determine and implement learning outcomes for students with special needs is crucial for improving instructional quality (Sözbilir, Kutu & Yasar, 2012).

Students with visual impairments encounter significant difficulties in science learning due to the abstract and visually dominant structure of the subject (Bülbül, 2013; Aktaş & Argün, 2021). This necessitates the development of differentiated and multisensory instructional strategies (Sellioğ & Sürmeli, 2025; Zorluoğlu & Kızılaslan, 2019). Alternative methods—such as auditory descriptions, tactile materials, Braille texts, and descriptive narration—not only improve access to content but also enhance students' active participation (Kızılaslan & Sözbilir, 2022; Ünlü, Pehlivan & Tarhan, 2010).

The practical implementation of inclusive education requires that teachers adopt flexible and student-centered approaches that accommodate individual differences (Sellioğ & Sürmeli, 2025). This involves diversifying not only instructional materials but also learning outcomes and assessment methods. Since traditional written exams often fail to capture the true performance of students with special needs, the use of alternative assessments—such as oral presentations, project-based applications, and performance-based evaluations—is increasingly recommended (Salend, 1998; Villanueva *et al.*, 2012). For instance, verbal explanations of visual materials can significantly aid students with visual impairments. While hands-on instruction effectively supports concept development, it may present participation barriers for students with physical disabilities. Computer-assisted instruction, on the other hand, can enhance learning through audiovisual materials, though many traditional teaching methods lack appropriate adaptations for students with special needs (Uzoğlu & Denizli, 2017).

Given the direct impact of sensory disabilities on learning processes, it is essential that instructional materials and methods be designed in accordance with students' perceptual characteristics (Cavkaytar & Diken, 2012; Sarı, 2005). The difficulty students with intellectual disabilities have in grasping abstract concepts underscores the need for additional support and adaptations in teaching (Mastropieri & Scruggs, 2016; Çapraz, 2016; Demir, 2008). Therefore, teachers must be equipped not only with strong subject knowledge but also with adequate competencies in special education (Sözbilir, Kutu & Yasar, 2012). Melber (2004) highlights the importance of structured in-service training programs that address both theoretical and practical dimensions of inclusive education. International frameworks mandate that education be delivered in an inclusive and rights-based manner. While the *Salamanca Statement* (UNESCO, 1994) asserts that all individuals, regardless of differences, have the right to be educated together, the *UN Convention on the Rights of Persons with Disabilities* (2008) emphasizes the necessity of an educational model free from discrimination. These principles call for a comprehensive restructuring of science education to ensure accessibility for all.

In practice, however, structural and pedagogical challenges frequently undermine the effectiveness of inclusive teaching. Issues such as curriculum overload, restricted instructional time, and a lack of adapted materials for students with special needs are among the most pressing concerns voiced by teachers (Sellioğ & Sürmeli, 2025; Villanueva *et al.*, 2012). Accordingly, a streamlined curriculum that focuses on essential concepts—as proposed in the "big ideas" approach—has been suggested (Villanueva *et al.*, 2012; Ayas, Çepni & Akdeniz, 1993).

The heavy reliance on visual materials in science classrooms presents considerable challenges for students with special needs. Kızılaslan and Sözbilir (2022) advocate for the widespread use of multisensory materials. Tactile graphics, auditory experimental tools, and digital simulations—when combined with Braille texts and three-dimensional models—can significantly support the concretization of abstract scientific ideas (Ünlü, Pehlivan & Tarhan, 2010; Hill, 2013). Furthermore, the integration of digital technologies has been shown to enhance the accessibility of learning processes for individuals with attention and memory difficulties (Evmenova & Behrmann, 2011).

In this regard, conducting a comprehensive analysis of how science teachers select and implement learning outcomes for students with special needs is essential not only for improving instructional quality but also for promoting inclusive education. Addressing teachers' needs through targeted in-service training and strengthening interdisciplinary collaboration holds considerable potential to enhance the academic success of students with special needs in science education (Sözbilir, Kutu & Yasar, 2012; Sellioğ & Sürmeli, 2025). However, the literature shows little in the way of complete or systematic study of science teachers' use of strategies to select and implement learning outcomes for students with special needs. In this research, we will fill the gap by studying such practices. The results will provide tools for policymakers and practitioners toward the development of inclusive science education. In a complete analysis of science teachers' processes to assess and enact educational outcomes for students with special needs, this research will make a solid contribution to the continuing process of establishing and improving inclusive educational practices.

2. Methodology

2.1 Research Design

This study adopts a qualitative research design aimed at gaining an in-depth understanding of how science teachers identify and implement learning outcomes for students with special needs. Specifically, a case study approach was employed, as it allows for a comprehensive examination of a specific phenomenon within its natural context (Yıldırım & Şimşek, 2018). This design is particularly well-suited for exploring the experiences, attitudes, and practices of teachers regarding inclusive education in a contextual and detailed manner.

2.2 Participants

The group involved in the study included 59 science teachers from a variety of provinces in Turkey who taught students with special needs. Participants were selected using maximum variation sampling, to capture some diversity and represent the views of teachers who have a wide range of professional backgrounds and professional experience, and those who work with a broad range of disabilities. The variety of teachers enhanced the richness and breadth of the data collected. Information on the characteristics and professional backgrounds of the study participants was recorded in detail to provide depth and context for the findings of the study..

2.3 Data Collection

Data were gathered using a semi-structured interview form developed specifically for this study. This form was influenced by the literature search that was completed in the areas of instructional modifications in special education, the consideration of individual education plans (IEP), and various instructional methods in teaching science education. The interview form consisted of open-ended questions, prompt questions, and focused questions relating to the teachers' criteria used in selecting learning outcomes, the challenges of implementing those outcomes, and their strategies in interpreting their practices in science education (Creswell, 2018: 77).

To assess the content validity of the format, feedback was obtained from academic experts from both special and science education disciplines during the review process and adjusted the interview form documentation. Participant feedback was also obtained from a focus group of teachers to assess the clarity and viability of the questions in the lethargy of a pilot study. Interviews were conducted, face-to-face, using telecommunication, or online search repositories, depending on participant availability, and recorded using Google Forms documentation. The interviews were set up to help the participants feel comfortable and relaxed, to allow for honest, thick, heavy detail responses.

2.4 Data Analysis

The collected qualitative data were analyzed using content analysis, following a systematic and rigorous process. In the initial stage, all interview recordings were transcribed verbatim and digitized. The transcripts were then broken down into meaning units, which were subsequently coded. Both open coding and schematic coding techniques were employed to ensure comprehensive analysis (Creswell, 2018; Yıldırım & Şimşek, 2018). Initially, each researcher performed coding independently. The codes were then compared, and discrepancies were discussed and resolved through consensus, resulting in the formation of coherent themes. These themes were further organized into five major categories:

1) Regulatory Frameworks,
2) Individualized Planning,
3) Student Characteristics,
4) Curricular Adaptation,
5) Instructional Methods.

Each theme was supported by subthemes and elaborated with descriptive explanations. For example, the theme "Individualized Planning" included discussions on the preparation of IEPs and assessment practices, while "Instructional Methods" encompassed the use of concrete materials, differentiated instructional strategies, and personalized repetition techniques.

To increase the reliability of the coding process, inter-rater agreement was calculated using Cohen's Kappa coefficient, which yielded a high reliability score exceeding 90%. Any coding inconsistencies were resolved through collaborative discussions among the researchers. Additionally, software tools such as MAXQDA were utilized to manage the data systematically and ensure consistency in theme development.

2.5 Ethical Considerations

All phases of the research adhered strictly to ethical guidelines. Participants were clearly informed about the purpose, scope, and voluntary nature of the study. Informed consent was obtained both verbally and in writing. Confidentiality was ensured by anonymizing personal identifiers, and each participant was assigned a unique code used throughout the interview documentation.

The data collected were used exclusively for academic research purposes. To protect participants' privacy, no identifying information was disclosed in any part of the study. The research was approved by the Ethics Committee of the relevant university and was conducted in full compliance with existing regulations and ethical standards.

3. Findings

This study investigated the ways that science teachers select and develop learning objectives for students with special needs. In the findings, the data were presented and indexed against five categories: choice of sources in developing learning objectives;

considerations in the planning of individualization; adjustments and modifications to the program that considered student attributes; alignment with curriculum; and teaching methods. In addition, the research characterized teacher responses on their sources of influence and the types of approaches they employed when dealing with students with disabilities: concretization, simplification of concepts, modification, sensory approach, and technology. Below are tables showing teacher statements and frequency distributions of the data, followed by interpretive comments.

Table 1: Sources Utilized by Science Teachers in Selecting Learning Objectives in Special Education

Theme	Subtheme	Sample Teacher Responses
Official Guidelines	MoNE Regulations	T3: "*We plan according to the criteria outlined in MoNE's special education regulations*." T12: "*We take the national curriculum as a basis and adapt it to the student*." T45: "*We follow the MoNE's framework for special education*."
	Guidance Reports (RAM)	T5: "*We determine targets based on the performance level in the RAM report*." T18: "*We evaluate both the guidance service and RAM recommendations*." T56: "*We prioritize RAM-suggested objectives in IEPs*."
Individual Planning	IEP Implementation	T7: "*We break down long-term IEP goals into monthly segments*." T15: "*We involve parents in planning*." T30: "*We make joint decisions with other subject teachers during IEP meetings*."
	Preliminary Assessment	T9: "*Initial evaluations at the start of the year guide our instructional roadmap*." T25: "*We plan based on gaps identified in baseline assessments*." T33: "*We conduct multi-dimensional evaluations to identify students' strengths*."
Student Characteristics	Type/Severity of Disability	T1: "*I use visual schedules for my student with autism*." T10: "*I emphasize lip-reading techniques for my hearing-impaired student*." T28: "*I prioritize social skills for my student with Down syndrome*."
	Learning Pace	T4: "*If a concept takes three weeks to grasp, I allow that time*." T21: "*I provide extra repetitions compared to other students*." T39: "*I adjust weekly goals according to individual pace*."
	Daily Life Skills	T6: "*I teach practical skills like shopping and calculating change*." T17: "*We organize field trips to teach public transport use*." T31: "*I prioritize self-care skills like eating and dressing*."

Curriculum Alignment	Curriculum Adaptation	T8: "*I simplify 8th-grade topics to a 4th-grade level.*" T20: "*Instead of experiments, I assign simple observations.*" T47: "I adjust content to make it more understandable."
	In-Class Parallelism	T14: "*I teach the same topic but assign different tasks.*" T26: "*I include the student in activities but set separate expectations.*" T53: "*I simplify test questions for the inclusion student.*"
Instructional Methods	Use of Concrete Materials	T11: "*I use beans to teach counting.*" T29: "*I teach concepts with colorful cards and images.*" T48: "*I conduct tactile writing exercises.*"
	One-on-One Repetition	T16: "*We review previous content for 5 minutes in each lesson.*" T37: "*I hold two one-on-one sessions weekly.*" T59: "*We frequently revisit forgotten topics.*"

Based on the data provided in the table, science teachers generally refer to regulatory documents and RAM reports when determining educational objectives for students with special needs. With respect to individualised planning, there is a conspicuous focus on IEP implementation and pre-assessments at the start of the school year. Adaptations for student characteristics--most commonly disability type, rate of learning and daily living skills--are part of daily practice. Teachers also regularly simplify the curriculum and vary classroom activities in alignment with the curriculum. Of the pedagogy they engage in, the common use of physical materials and the individualisation of practice sessions were referred to as preferred practices.

Table 2: Strategies for Concretization and Adaptation in Science Instruction

Theme	Subtheme	Sample Teacher Responses
Concretization	Experiential Learning Tools	T12: "*We create 3D cell models using foam and clay; my visually impaired student distinguishes organelles by touch.*" T25: "*In force and motion, I show how to make simple spring scales—students learn by building their own tools.*"
	Multisensory Demonstrations	T3: "*We demonstrate states of matter by melting ice and boiling water—students grasp better through touch.*" T34: "*To explain sound waves, I pop balloons and create ripples in water; my hearing-impaired student learns via vibration.*" T41: "*We build circuits with simple materials. The students get excited when they see the bulb light up.*"
Simplification	Conceptual Analogies	T7: "*I explain photosynthesis as 'plants cooking their food' and describe chlorophyll as the 'plant's kitchen'.*" T27: "*I define DNA as the body's codebook, comparing nucleotides to letters.*"
	Practical Examples Without Technical Details	T11: "*I teach respiration simply as 'lungs take in air and release carbon dioxide.*" T19: "*I explain acids and bases using lemon as sour and soap as bitter, skipping the pH scale entirely.*"

		T36: "*I use only basic examples like 'electricity turns into heat' to teach energy conversions.*"
Adaptation	Flexible Scheduling and Pacing	T5: "*I stretch one-lesson experiments over three lessons with frequent repetition.*" T14: "*I divide lessons into 15-minute modules and add 5-minute breaks.*"
	Individualized Assessment and Support	T8: "*I allow 80 minutes instead of 40 for tests and break questions into smaller parts.*" T22: "*I adjust the annual plan based on the student's learning pace, skipping some units.*" T39: "*I give additional time for lab activities and avoid rushing the student.*"
Sensory Learning	Use of Multiple Sensory Inputs	T15: "*In sound lessons, students play musical instruments and feel the vibrations with their hands.*" T18: "*I use strong scents like mint and lemon to explain the sense of smell.*" T24: "*I teach taste with sugar, salt, and lemon samples.*"
	Sensory Exploration of Physical Phenomena	T31: "*I use various textured materials (e.g., sandpaper, silk, wool) to teach touch.*" T40: "*We explore thermal conductivity by heating metals—safely, of course—so they can feel the warmth.*"
Technology Integration	Interactive Digital Simulations and Visualizations	T21: "*I use PhET simulations on tablets—students explore planets by interacting with them.*" T9: "*I show cell structures with augmented reality applications.*"
	Multimedia and Gamified Learning	T16: "*I make learning fun with educational science games like Kahoot.*" T29: "*We use a computer-connected microscope to magnify images—it really grabs their attention.*" T37: "*I show simple science experiment videos on YouTube so they can repeat them at home.*"

This table illustrates the diverse strategies employed by science teachers in special education settings to enhance concept accessibility and engagement. Concretizing abstract content through experiments and tangible materials significantly improves comprehension for students with special needs. Simplification of complex scientific ideas into relatable analogies and everyday language is another widely used technique. Flexibility in lesson duration and content pacing accommodates individual learning rates. In addition, multisensory methods—engaging touch, smell, hearing, and taste—are frequently adopted to provide richer learning experiences. Lastly, the integration of digital tools and simulations makes science education more interactive, visually stimulating, and accessible for learners with varying needs.

4. Discussion

Ensuring equitable access to science education for students with special needs is widely recognized as an integral component of the universal right to education and a fundamental human right (UNESCO, 1994; UNCRPD, 2008). However, the inherently abstract nature of scientific concepts, the visual intensity of instructional materials, and the hands-on requirements of laboratory work pose significant challenges for these students (Bülbül, 2013; Aktaş & Argün, 2021). Consequently, inclusive science education must go beyond mere access, requiring the thoughtful adaptation of both content and pedagogy to meet diverse learner needs.

Findings from this study reveal that science teachers employ multifaceted strategies when identifying and implementing learning objectives for students with special needs. Yet, the success of these strategies is closely tied to several contextual factors, including teachers' professional competence, available school resources, and broader educational policy support. In this respect, the study offers both a current assessment of inclusive science practices and a framework for improvement based on the literature.

In Turkey, IEPs for pupils with special needs are made by teachers in line with the regulations of the national government - Ministry of National Education (MoNE) - and the support of the Counseling and Research Centers (RAM) as defined in the legislation. The IEP requirements positioned in these national laws (MoNE, 2007) and internationally (UNESCO, 1994) by the umbrella for Inclusive Education all focus on the individual performance levels of a student but due to existing literature, there are serious issues available to ascertain the 'working' of IEPs. For example, Sellioğ and Sürmeli (2025) state the IEP documents provided are created simply to satisfy legal obligations and opportunities for implementation and follow up are very few. Although it is deemed ideal for Members to engage with subject teachers and families, the opportunity for ongoing engagement with these Members is impeded through the pressure of teacher workloads and time constraints (Cavkaytar, 2013). Villanueva *et al.* (2012) also identify that an IEP tends to be a document based around goal setting without coherent monitoring of the student situation. To be of real value, IEPs need considerable enhancement around procedures for implementation and evaluation.

The literature proposes several ways to enhance the functionality of IEPs. Digital platforms for planning and monitoring may help reduce the time burden on teachers and facilitate tracking. Moreover, the establishment of school-based interdisciplinary support teams—including guidance counselors, subject teachers, and families—could enhance coordination and sustainability. Providing mentoring support from experienced special education professionals may also help teachers overcome challenges during the planning and implementation phases. These improvements would help transform IEPs from a bureaucratic obligation into a dynamic tool that genuinely supports student development.

In teaching abstract science concepts to students with special needs, concrete and multisensory instructional strategies are gaining prominence. Our findings indicate that teachers utilize various techniques to make abstract concepts more accessible. For instance, tactile materials such as styrofoam and modeling clay enable visually impaired students to engage with content through touch, facilitating deeper learning (Ünlü, Pehlivan & Tarhan, 2010). Teachers also use analogies and metaphors, such as describing photosynthesis as "*plants making their own food*," to simplify concepts and improve comprehension (Mastropieri & Scruggs, 2016). Additionally, sensory experiences—like vibration or tactile feedback—have been shown to enhance the engagement of students with hearing impairments (Kızılaslan & Sözbilir, 2022).

While these approaches have been effectively used, limitations may keep teachers from implementing these approaches. Often, teachers report not having access to tactile graphics, Braille materials, and adapted laboratory materials (Sarı, 2005). Many teachers report that they simply had insufficient training in-service to develop and use instructional materials for different learners (Sözbilir, Kutu & Yaşar, 2012). Uzoğlu and Denizli (2017) were more specifically concerned about students with orthopedic impairments and indicated that although experimental activities help students acquire concepts, they are not accessible to students with orthopedic impairments. Equally, their study indicated that the use of computer-assisted instruction and multimedia content and other methods, like Kahoot, have added more value than traditional lessons, especially when planned for doing so as opposed to excluding students with special needs.

Technology would be a useful assistance for these limitations, especially with augmented reality tools or by using simulations that help illustrate more abstract science content. For example, the PhET simulations are proven to create visualizations in some complicated topics (Evmenova & Behrmann, 2011). Kahoot is another educational game that provides collaboration and engagement opportunities to make learning more relevant. However, there are institutional operational norms to adopt technological models for digital tools in education with schools (Hill, 2013), coupled with teachers' personal struggles adapting technology for learners with special requirements. Supporting the integration of new technology into practice with strategies will require some kind of directed strategies for more effective approaches in this space, without changing the essence or meaning of their inclusive classroom.

Curriculum adaptation is another area in which teachers often simplify content to align with students' developmental levels—such as modifying 8th-grade content to suit a 4th-grade level. While this approach aligns with the "big ideas" principle in science education (Villanueva *et al.*, 2012), excessive simplification may risk lowering academic expectations (Ayas, Çepni & Akdeniz, 1993). Thus, curriculum modifications must strike a balance between accessibility and the preservation of academic rigor.

Regarding pacing, teachers reported extending test durations and spreading experiments over multiple lessons, both of which allow students more time to process information and demonstrate their learning (Salend, 1998). Yet, the rigidity of the curriculum and pressure from standardized exams often limit the feasibility of such flexible instructional adjustments (Sellioğ & Sürmeli, 2025). Therefore, inclusive science education requires not only flexible instructional strategies but also structural support that enables meaningful curriculum adaptation.

5. Conclusion

The findings of this study highlight that science teachers actively engage in developing and applying various strategies to accommodate students with special needs. Teachers often rely on MoNE guidelines, RAM reports, and IEPs to guide their planning, reflecting both adherence to regulatory frameworks and an effort to address individual student needs. However, persistent challenges in IEP implementation—particularly time constraints and a lack of interdisciplinary collaboration—limit the overall effectiveness of these plans. This underscores the need for inclusive education to be supported not just by policy but through practical, school-level mechanisms.

In terms of methods and content in science teaching, a focus of science specialist teachers is the modification of pedagogy and content based on characteristics of students, like type of disability, stages of cognitive development and pace of learning. Typically, when working with students with disabilities, teachers will utilize different types of experiments, tactile resources and real-world examples to cover abstract concepts. In addition to modifying the content, simplification of the content and flexible learning time are also effective strategies. However, the degree of adaptation or modification one can do with their teaching depends on their availability of resources and materials. The lack of technology and adapted resources remains a major barrier.

Technology provides important opportunities to facilitate inclusive science teaching. For instance, augmented reality (AR), digital simulations and educational games can aid in student engagement and facilitate understanding of abstract concepts. However, access to these technology tools is an ongoing challenge based on other classroom needs and teachers' confidence in using them. Improving facilities and providing professional development are part of improving inclusive science education.

With regard to the adaptations of the curriculum, teachers are typically using content simplification and activity style differentiation. These practices undoubtedly assist in the accessibility of students' learning. However, there is a danger of oversimplification and a negative impact on the growth of scientific thinking skills (for example). A further problem is that the large amount of knowledge to be taught and the consistency of tied assessments limit teacher flexibility and their ability to maximize their potential for teaching. The new curriculum needs to better reflect the needs of students, particularly students who may access special needs services, which would lessen some of the restrictions on teachers. Similarly, there needs to be some level of practical guidance provided for teachers regarding managing adaptations.

In conclusion, overall the study has shown that science teachers are working well to support students with special needs, but barriers remain in the system and are still limiting the effect of their work. Expanding the quality of inclusive science teaching and learning requires continual professional development, improvement of school infrastructure, and a reformulation of the curriculum for greater flexibility. Additions of collaborative, interdisciplinary and parental engagement will enable a more holistic response to students' individual needs. This is all necessary to respond to the learning and best support students with special needs so they can have positive and inclusive experiences through science education, and to ensure that inclusive practices become sustained, embedded parts of educational systems.

6. Recommendations

6.1 Improvement of the IEP Process

The value of IEPs is starting to necessitate the use of digital platforms. Digital platforms not only facilitate the planning and monitoring of student progress but also assist teachers in managing their work time as well. Interdisciplinary teams (guidance, subject teacher, parents) will also support the development of more realistic and sustained IEPs. By collaborating, these teams will help to better monitor student learning in a multi-faceted manner.

6.2 Supporting Teachers' Development

Inclusive science education requires teachers to participate in a breadth of in-service training surrounding expertise to affect both pedagogical and practical competencies. This includes the creation and subsequent checking of instructional materials, using assistive technology and using differentiated instruction. Mentoring programs that engage experienced special education practitioners may also assist in providing guidance and involvement to support teachers in growing their confidence and competence in terms of effective IEP design and implementation.

6.3 Increasing Access to Inclusive Learning Materials

To enable students with special needs to fully participate in science classes, instructional resources that are accessible to them need to be widely available. These could include things like Braille textbooks, tactile graphics, or audio-described kits for experiments. There are also digital tools, including augmented reality applications and simulations such as PhET, which can be very effective for representing abstract scientific ideas and concepts in a more tangible way. For the tools to be maximally effective, however, technical support and investigation of augmented reality and simulations are critical for teachers.

6.4 Curriculum Adaptations According To Individual Needs

Curriculum adaptations should not only be simplifications of the content but also provide students with a framework that can be organized around a series of "big ideas" that are foundational ideologies for grasping science. For assessments, similarly, flexibility is needed to enable a variety of responses. For example, it may be appropriate to provide students with extended time, oral assessment, and project assessment as one option, so students can demonstrate a demonstration of understanding according to preferred learning and accessibility styles.

6.5 Strengthening Collaborative Networks

The success of inclusive education depends heavily on sustained collaboration among teachers, families, and specialists. Expanding the involvement of local authorities and non-governmental organizations can help mobilize additional financial and structural resources. For instance, redesigning science laboratories based on principles of universal design would facilitate more active participation by students with disabilities, thereby fostering more inclusive and engaging learning environments.

Conflict of Interest Statement

The author declares no conflicts of interest.

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References

American Association for the Advancement of Science. (1993). *Benchmarks for science literacy*. Oxford University Press. Retrieved from https://www.aaas.org/resources/benchmarks-science-literacy

Ayas, A., Çepni, S., & Akdeniz, A. R. (1993). Development of the Turkish secondary science curriculum. *Science Education, 77*(4), 433-440. https://doi.org/10.1002/sce.3730770406

Birleşmiş Milletler (2008). *Engellilerin haklarına dair sözleşme*. http://www.tiemf.org.tr/arsiv/mevzuatlar/bm_engellihaklarisozlesmesi.pdf

Boyle, J. R., & Scanlon, D. (2009). *Methods and strategies for teaching students with mild disabilities: A case-based approach*. Cengage Learning. Retrieved from https://learningally.org/bookdetails/bookid/JR960

Bülbül, M. Ş. (2013). Görme engelli öğrenciler ile grafik çalışırken nasıl bir materyal kullanılmalıdır? *Fen Bilimleri Öğretimi Dergisi, 1*(1), 1-11. https://dergipark.org.tr/en/pub/fbod/issue/71994/1158016

Cavkaytar, A. (2013). Özel eğitime gereksinim duyan çocuklar ve özel eğitim. İ. H. Diken (Ed.), *Özel Eğitime Gereksinimi Olan Öğrenciler ve Özel Eğitim* içinde (ss. 1-25). Pegem Akademi. http://dx.doi.org/10.14527/9786055885267.01

Cavkaytar, A., & Diken, İ. H. (2012). *Özel eğitim 1: Özel eğitim ve özel eğitim gerektirenler* (1. baskı). Vize Basın Yayın. Retrieved from https://www.nadirkitap.com/ozel-egitim-1-ozel-egitim-ve-ozel-egitim-gerektirenler-atilla-cavkaytar-ibrahim-h-diken-kitap22409716.html?srsltid=AfmBOor4RfLXPW64QDPHspCx9Ei26S2D6pFx6kmDQUnUSC0EubD3ZydB

Çapraz, C. (2016). *Ortaokul özel alt sınıfta öğrenim gören zihinsel yetersizliğe sahip öğrencilere bazı maddelerin "katı, sıvı ve gaz" hallerinin doğrudan öğretim yöntemiyle öğretimi* [Yayınlanmamış doktora tezi]. Atatürk Üniversitesi.

Creswell, J. W. (2018). Nitel araştırma yöntemleri. (M. Bütün & S. B. Demir, Çev.). Siyasal Kit=abevi.

Demir, R. (2008). *Zihinsel engelli öğrencilere fen bilgisi dersinde sindirim konusunu basamaklandırılmış öğretim yöntemiyle sunulmasının etkililiği* [Yayınlanmamış yüksek lisans tezi]. Selçuk Üniversitesi.

European Commission. (2007). *Science education now: A renewed pedagogy for the future of Europe*. Publications Office. Retrieved from https://op.europa.eu/en/publication-detail/-/publication/4f9e2b90-1c7b-4d56-9e30-9e9e7f4c6e5a

Evmenova, A. S., & Behrmann, M. M. (2011). Research-based strategies for teaching content to students with intellectual disabilities: Adapted videos. *Education and Training in Autism and Developmental Disabilities, 46*(3), 315-325.

Hill, H. (2013). Disability and accessibility in the library and information science literature: A content analysis. *Library & Information Science Research, 35*(2), 137-142. https://doi.org/10.1016/j.lisr.2012.11.002

Kızılaslan, A., & Sözbilir, M. (2022). Görme yetersizliği olan öğrencilere kinetik enerji ve sıcaklık kavramlarının öğretimi. *Bayburt Eğitim Fakültesi Dergisi, 17*(34), 606-624. https://doi.org/10.35675/befdergi.836349

Mastropieri, M. A., & Scruggs, T. E. (2016). *Kaynaştırma sınıfı: Etkili farklılaştırılmış öğretim için stratejiler* (M. Şahin & T. Altun, Çev.). Nobel Akademik Yayıncılık. (Orijinal çalışma basım tarihi 2010). Retrieved from https://books.google.ro/books/about/KAYNA%C5%9ETIRMA_SINIFI_Etkili_Farkl%C4%B1la%C5%9Ft.html?id=9Ug_EQAAQBAJ&redir_esc=y

Milli Eğitim Bakanlığı. (2007). *Çocuk gelişimi ve eğitimi*. MEB Yayınları. Retrieved from https://megep.meb.gov.tr/mte_program_modul/moduller_pdf/Geli%C5%9Fim.pdf

Milli Eğitim Bakanlığı. (2008). *Özel eğitim ve rehabilitasyon merkezi zihinsel engelli bireyler destek eğitim programı*. MEB Yayınları.

National Research Council. (1996). *National science education standards*. National Academy Press.

OECD. (2006). *Evolution of student interest in science and technology studies*. OECD Publishing. Retrieved from https://doi.org/10.1787/9789264016182-en

Salend, S. J. (1998). Using an activities-based approach to teach science to students with disabilities. *Intervention in School and Clinic, 34*(2), 67-72. https://doi.org/10.1177/105345129803400201

Sarı, H. (2005). Selçuk üniversitesinde öğrenim gören bedensel engelli ve görme engelli öğrencilerin karşılaştıkları sorunlar ve çözümüne yönelik çağdaş öneriler. *Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 13*, 335-355. Retrieved from https://dergipark.org.tr/tr/download/article-file/1722266

Sellioğ, A., & Sürmeli, H. (2025). Evaluation of science education for students with visual impairment: Views of teachers and administrators. *Ankara University Faculty of Educational Sciences Journal of Special Education, 26*(2), 147-165. https://doi.org/10.21565/ozelegitimdergisi.1389193

Sözbilir, M., Kutu, H., & Yasar, M. D. (2012). Science education research in Turkey: A content analysis of selected features of papers published. In J. Dillon & D. Jorde (Eds.), *The world of science education: Handbook of research in Europe* (pp. 1-35). Sense Publishers. http://dx.doi.org/10.1007/978-94-6091-900-8_14

UNESCO. (1994). *The Salamanca statement and framework for action on special needs education*. UNESCO. Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000098427

Ünlü, P., Pehlivan, D., & Tarhan, H. (2010). Ortaöğretim kurumlarında öğrenim gören görme engelli öğrencilerin fizik dersi hakkındaki düşünceleri. *Gazi Eğitim Fakültesi Dergisi, 30*(1), 39-54. Retrieved from https://dergipark.org.tr/tr/pub/gefad/issue/6742/90646

Villanueva, M. G., Taylor, J., Therrien, W., & Hand, B. (2012). Science education for students with special needs. *Studies in Science Education, 48*(2), 187-215. https://doi.org/10.1080/03057267.2012.733880

Uzoğlu, M., & Denizli, H. (2017). Fen Bilimleri Dersini Alan Kaynaştırma Öğrencilerinin Kaynaştırma Uygulamaları Sürecine İlişkin Görüşleri. Mersin Üniversitesi Eğitim Fakültesi Dergisi, 13(3), 1271-1283. https://doi.org/10.17860/mersinefd.372160

Yıldırım, A., & Şimşek, H. (2018). Sosyal bilimlerde nitel araştırma yöntemleri. Seçkin Yayıncılık. Retrieved from https://www.seckin.com.tr/kitap/sosyal-bilimlerde-nitel-arastirma-yontemleri-ali-yildirim-hasan-simsek-s-p-116659534?srsltid=AfmBOoqa4Fgs3aG0OqbK9qruysZGhhosRqpeIGTOW9nurgj355VDq0xL

Zorluoğlu, S. L., & Kızılaslan, A. (2019). Görme yetersizliği olan öğrencilere fen eğitimi: İlkeler ve stratejiler. *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi, 51*, 315-337. https://dergipark.org.tr/tr/pub/maeuefd/issue/47282/514423