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Differentiated instruction science learning for intellectually disabilities pupils at an inclusive primary school: A case study

Norma Yunaini [1], Ali Mustadi[2], Mumpuniarti[3], Ishartiwi[4], Riyan Hidayat[5]

[1]*Universitas Muhammadiyah Pringsewu Lampung and Universitas Negeri Yogyakarta, Indonesia, ORCID ID: 0009-0001-1522-781X*
[2]*Universitas Negeri Yogyakarta, Indonesia, ORCID ID: 0000-0002-7620-4582*
[3]*Universitas Negeri Yogyakarta, Indonesia, ORCID ID: 0000-0001-8063-7957*
[4]*Universitas Negeri Yogyakarta, Indonesia, ORCID ID: 0000-0002-7881-5547*
[5]*Universiti Putra Malaysia, Malaysia, Corresponding author, riyan@upm.edu.my, ORCID ID: 0000-0002-7962-0194*

ABSTRACT
Differentiated instruction (DI) is an approach to learning that allows teachers to meet the unique needs of pupils in the classroom. This study aimed to explore the extent to which DI is implemented in learning to improve the science process skills (SPS) of Intellectually Disabilities (ID) pupils in inclusive primary school education. This research was of the qualitative study type with case study design in 5 inclusive primary schools in Indonesia. The subjects of the study were five teachers who had experience teaching in inclusive primary schools. The sampling method used was purposive sampling, while the data collection the technique used is an in-depth interview. For data analysis techniques, content analysis and descriptive qualitative analysis were used. The results showed that teachers still face challenges in implementing DI for ID pupils in science subjects in inclusive primary schools, despite efforts to understand and implement DI, teacher readiness is still limited, especially in terms of: 1) planning the implementation of learning according to the needs of ID pupils; 2) plan teaching materials that are in accordance with the abilities of ID pupils; 3) lack of DI-related teacher training and coaching in inclusive primary schools. The implication of this study is the need to increase teacher readiness in implementing DI effectively for pupils with special needs, especially in science in inclusive primary schools.

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Introduction

Within the framework of the curriculum, science education is designed to introduce the basic principles of science to pupils of school age. Science education in primary schools aims to train pupils to be able to investigate natural phenomena through a scientific process based on a scientific attitude (Trilling & Fadel, 2009). There are three important aspects of science learning, namely, science as a scientific attitude, science as a process, and science as a product (Pakombwele & Tsakeni, 2022). Science is delivered through the integration of scientific processes, the concept of process integration is explained as follows: science seeks explanations of nature systematically (Chiappetta & Koballa, 2010;

Hidayat et al., 2021). Science as a process or called Science Process Skills (SPS) refers to the main skills used by scientists to conduct research aimed at addressing scientific problems and providing explanations about natural phenomena (Darmaji et al., 2020). SPS is considered important not only for scientists but also for students in elementary school so that students can better answer various problems (Sideri & Skoumios, 2021).

Molefe and Aubin (2021) highlighting the focus of science education in several countries emphasized on the development of critical responsibility for the environment and the application of SPS in the investigation of natural phenomena. This method is believed to be effective as a structured scientific process for pupils to explore their knowledge (Chakravartty, 2023; Zulueta & Panoy, 2022). The ability of SPS in students is characterized by having competence for critical thinking, communication, collaboration, scientific problem solving skills, and being able to find solutions to problems that pupils face in everyday life (Çoruhlu et al., 2023; Kaymakcı & Can, 2021; Sujana & Wayan Puniawati, 2020). Pupils natural skills are an important foundation in a variety of cognitive experiences that enable students to build a deep knowledge and understanding of science (Özgelen, 2012). But unfortunately, the literature review on SPS in general focuses more on junior and senior high schools (Şenel et al., 2022).

Based on previous research and systematic reviews, few studies have focused on students with special needs in the process of learning science at the elementary school level. 17% of the 199 articles specifically focused on pupils with cognitive or Intellectual Disabilities (ID) (Comarú et al., 2021). The results of another study also showed that out of 100 articles that reviewed science education for students with special needs were still in the minimal category (Tosun, 2022). These findings illustrate the importance of focusing on pupils with special needs in the science learning process to ensure equity and opportunities in learning. By creating inclusive environments, pupils with special needs receive the necessary support to meet their educational requirements, also thereby fostering acceptance and tolerance for individual differences (Mendoza & Heymann, 2022; Sanger, 2020). Various schools and organisations have implemented inclusive programmes, placing pupils according to their needs and providing training for educators (Lawal et al., 2022; Maulida, 2019; Roldán et al., 2021; Sheehy et al., 2019; Utami et al., 2024). However, inconsistencies in placing children with special needs in inclusive settings have at times been observed (Krämer et al., 2021; Woodcock et al., 2022). The effectiveness of inclusion at primary school level remains debated, as findings indicate no significant impact on learning performance or psychosocial adjustment for pupils with special needs (Puomila, 2019). Inclusive schools may need to reassess and improve individualisation and differentiation to meet specific needs, especially for pupils categorised as ID (Dalgaard et al., 2022; Hanreddy & Östlund, 2020; Lindner & Schwab, 2020). Pupil ID in inclusive schools shows resistance to difficult science tasks, impact on learning motivation decreases (Bandura, 1977; Çoruhlu et al., 2023).

SPS are vital for constructing knowledge concepts (Faisal & Martin, 2019), requiring learning experiences that facilitate the discovery of facts and the development of understanding (Mcginnis, 2013; Sholahuddin et al., 2020). SPS significantly contribute to science learning outcomes, assisting learners in obtaining meaningful information both within and outside science classes (Bhakti et al., 2018). However, a recent study indicates that a lack of knowledge about SPS can hinder learners' preparedness to employ relevant problem-solving strategies. The challenge faced by ID learners in developing SPS lies in learning approaches that neglect individual differences in abilities. Teachers in inclusive primary school continuously strive to enhance teaching quality by acknowledging individual differences and recognising the underlying and intrinsic nature of special educational needs (Hornby, 2015). The holistic learning and teaching process considers the social and psychological factors influencing individuals in the intricate and diverse learning journey (Cologon, 2020). In the context of learning science, the acquisition of science process skills is imperative, as these skills play a crucial role in the formation of scientific understanding, combining knowledge development with practical scientific activities (Sess, 2008). This integration enables learners to

enhance their comprehension of the surrounding environment and acquire skills applicable to diverse situations.

However, there are a number of challenges to implementing the science process in schools, principally the excessive emphasis on the content of science material. There is an excessive emphasis on rote memorisation of science content without a corresponding focus on understanding and practice (Dewi & Rahayu, 2023). This makes science come across as a collection of irrelevant information to IR learners. The science material taught is often unrelated to experience (Kala & Ayas, 2023). As a result, science learning becomes less interesting and less meaningful.

DI is an instructional approach that is pertinent for addressing the diverse learning needs within a classroom (Lawrence-Brown, 2020). Numerous studies have extensively documented the role of DI in the context of inclusive education (Lindner & Schwab, 2020; Vantieghem et al., 2020). It is based on a flexible curriculum (Suwastini, 2021). Previous study has shown that DI in inclusive education can improve learners' academic skills and increase their involvement in the learning process. However, the implementation of DI needs to be tailored to the needs and characteristics of learners, as well as involving sufficient support and training for teachers to be able to implement DI effectively (Demir, 2021; Kamila et al., 2023; Okutan & Eryilmaz, 2021). Studies focusing on the application of DI to process science skills in inclusive primary schooling is still very limited (Çoruhlu et al., 2023; Sideri & Skoumios, 2021). Therefore, there is a need for advanced study that explores the implementation of DI in science process skills for ID learners in inclusive primary schools This study focused on whether and how DI can be used to improve the science process skills of primary is learners. The research question is: To what extent, if any, does the implementation of DI improve the SPS of ID learners in inclusive primary education?

Literature Review

Differentiated Instruction

DI is an instructional approach that is responsive to the individual needs of learners based on their ability. One measure cannot be used for all learners, which means that one way of teaching or learning will not be suitable or appropriate for all learners (Tomlinson, 2003). Starting from this diversity, teachers should accommodate and differentiate (Tomlinson, 2001). DI uses a variety of methods, materials, and strategies to make learning more relevant and engaging for pupils with different needs (Dunn & Dunn, 2018). DI accommodates diverse learning styles and increases pupil engagement with learning content suitable for everyone (Sayuti, 2021). In DI, teachers respond positively and actively to pupil needs, both individually and through small groups (Tomlinson & Eidson, 2003). DI includes planning, execution and evaluation that focuses on the needs of individual learners; with this model, teachers can tailor materials, assignments, and feedback to ensuring that all pupils have a fair chance of succeeding (Pozas et al., 2020). By paying attention to the observations of teachers, they will focus on changing the way in which the curriculum is delivered (Hidayat & Wardat, 2023; Liu, 2021) State- or nationally approved curricula may determine the content of lessons taught (Jonker et al., 2020). However, teachers could adjust curriculum material so that it suits the learning style of their charges (Hasanah et al., 2022).

Teachers must ensure that the material delivered is available in various forms to meet diverse learning needs, such as listening to lessons, watching videos, doing practical exercises, and others (Pozas et al., 2020). The use of learning materials allows teachers to see which pupils have mastered the material and who may need further assistance (Maeng & Bell, 2015). Some topics have four or five different types of projects that pupils can choose from to demonstrate their knowledge of the topic (Algozzine & Anderson, 2010). Teachers strive to make elements of classroom instruction flexible to meet learner needs effectively. Teachers can prepare by evaluating the extent of pupils' readiness to work on the material to be taught and adjusting the material to meet their needs. In addition, teachers

can tailor material to meet learner needs based on their learning profiles, such as learning styles, cultural or gender-based preferences, and group orientation. DI has four aspects that can be controlled by teachers, namely content, processes, products, and the learning environment or climate in the classroom (Tomlinson, 2003).

Educators are urged to customise their teaching methods based on the diversity of learners, promoting a learning process rooted in individual styles, abilities and interests (Castiblanco et al., 2023). DI employs a range of techniques, materials and strategies to render learning pertinent and captivating for learners with varied needs, accommodating different learning styles and enhancing engagement. This approach entails teachers actively addressing pupil needs, undertaking planning, execution, and evaluation with a specific focus on individual requirements. This model enables teachers to personalise materials, assignments, and feedback, ensuring equal opportunities for success (Pozas et al., 2020). By comprehending and adapting to learner' readiness, interests, and learning profiles, educators can optimise the learning experience, adjusting elements of classroom instruction to flexibly meet diverse learner needs. DI, which teachers can control in terms of content, processes, products, and the learning environment, empowers instructors to deliver a more effective and pertinent learning experience for each student in their classroom (Maeng & Bell, 2015).

Inclusive Education

Inclusive education facilitates the participation of all pupils in one class, by ensuring that but DI often involves different activities for different ability groups without discrimination. The basic principle of an inclusive education system is that all children can learn together regardless of any differences that may exist between them (Sulasmi & Akrim, 2020). Inclusive education aims to create collaborative learning environments where pupils with special needs learn together with other pupils (Sen & Shahi, 2021). Based on the results of meta-analysis conducted by Carlberg and Kavale (1980) of 50 studies, Wang and Baker (1985/1986) of 11 studies, and Baker (1994) of 13 studies, inclusive education produces positive benefits for both the academic and social development of children with special needs and their peers (Carlberg & Kavale, 2016:24). (Daniel et al., 2023). Pupils with special needs have certain cognitive, behavioural, or physical needs issues that can interfere with the ability to learn, follow lessons, and interact with the school environment.

A special needs category is that of intellectual disabilities. The term ID is used in this study to describe pupils who need special help because they have learning difficulties arising from their limited intelligence (Fidler et al., 2022). Children who are categorised as intellectually deprived require special education services based on related individual and social needs (Williams et al., 2022). Charles Palmer Ingram categorised children who are slow learners as feeble minded (IQ less than 50), mentally disabilities (IQ 50-70), and mentally backward (IQ 75-89) (Ingram, 1941). The diagnosis for intellectual development disorders is the equivalent term for diagnostic ID. Although the term is widely used in the DSM V, both terms are also associated with other classification systems (Lennox et al., 1997). Children with IR need more time to absorb information related to the stimulus present in their situation.

In summary, inclusive education is a pedagogical approach that aims to facilitate the participation of all pupils in a single classroom, ensuring accessible learning activities without discrimination (Alkharraz, 2022). It asserts the right of individuals, irrespective of age, gender, ability, or background, to fully engage in community life. Restructuring schools is essential to create an environment supportive of fulfilling children's special needs in terms of subject matter, learning resources, and collaborative support from teachers, parents, and the community. The fundamental principle of inclusive education is the integration of all children into shared learning experiences, emphasising collaboration and understanding among learners with varying abilities (Wilson et al., 2017). There are learners with diverse characteristics in schools with an inclusive education system, namely those who exhibit normal development and those with special needs (Barbra & Joyline, 2014). Special needs pupils may present cognitive, behavioural, or physical limitations. Children with

intellectual disabilities require specialised educational services tailored to their individual and social needs (Corby et al., 2022).

Science Process Skills (SPS)

The most dramatic shift in science education in the last forty years has been a paradigm shift from an approach focused on factual knowledge to practices (Sabah et al., 2023). This marks a fundamental transformation in science education that not only emphasises what learners know, but also how they can learn and understand science more deeply through practical and interactive experiences. Science learning aims to cultivate scientific inquiry skills that are important for learners to gain their own experience (Kim, 2023).

SPS fall into two categories, namely basic process science skills (BSPS) and integrated process science skills (ISPS). BSPS provide an intellectual basis in scientific inquiry, such as the ability to sequence and describe natural objects and events through observing, classifying, measuring and predicting. BSPS is a prerequisite for integrated process science skills (Yap & Yap, 2020). ISPS is a terminal skill for solving problems or conducting scientific experiments. Examples of ISPS are identifying and defining variables, collecting and transforming data, creating tables and graphs of data, describing relationships between variables, interpreting data, manipulating materials, formulating hypotheses, designing investigations, inferring, and generalising information (Sideri & Skoumios, 2021). SPS are among the most important basic skills required in science experiments such as inferring, measuring, predicting, observing, communicating, and experimenting. Such skills help learners to understand the scientific phenomenon under investigation, find information and increase their sense of responsibility for their own learning (Idris et al., 2022). Pupils with special needs are taught to solve problems, communicate effectively, work together in groups, and explore the world around them through lessons such as science (Sibic & Sesen, 2022; Faisal & Martin, 2019) (Faisal & Martin, 2019b) science products (Solé-Llussà et al., 2022). Science learning in inclusive primary and secondary schools needs to pay attention to the characteristics and readiness of learners.

SPS that are very important for primary school pupils to master are the elementary stage skills intended for children aged 5-8 years (Mutlu & Kağan, 2013): observation, sorting, classification, serial ordering, operational definition and communication (Muhammad & Herdiyana, 2017). SPS is one of the most frequently used thinking skills, so individuals who cannot use SPS may have difficulty in their daily lives. According to the results of previous studies, the SPS of school children in some regions in Indonesia is very low (Irwanto et al., 2018). There are still many teachers who focus mainly on achieving learning outcomes than developing science process skills (Wilujeng et al., 2020). This is quite worrying because process skills involve organising and managing time, using learning strategies, planning and evaluating. Without proper science process skills, learners will not be able to achieve optimal science learning outcomes (Pratono et al., 2018). But much science education continues to emphasise the delivery of information through teacher explanations as the main source of learning. Learning activities tend to focus on copying knowledge from one teaching material to another so that learners are more likely to memorise the substance of the material than develop thinking process skills. Pupils with special needs relating to communication quickly forget the material learned because they lack the opportunity to participate in learning activities. They may become demotivated (Rusmini et al., 2021). In addition, SPS also increase feelings of responsibility and confidence in acquiring knowledge independently, increase knowledge retention, and provide opportunities for students to develop effective research methods (Sarıoğlu, 2023).

Science learning is directed to pupils to construct their own knowledge (Larison, 2022). IR pupils are able to learn science meaningfully through the exploration of science process skills (So et al., 2022). The implication for science teachers is that teachers must provide a learning environment with contextual activities that allow learners to develop and master science process skills according to their individual abilities and interests (Applefield et al., 2001). SPS encompass basic and integrated

skills, forming a crucial foundation for scientific inquiry. ISPS on the other hand, involve problem-solving and experimental techniques such as defining variables, collecting and transforming data, and formulating hypotheses. In inclusive primary schooling, attention to children's characteristics and readiness is crucial, particularly for those ID learners. The mastery of elementary stage SPS, such as observation, sorting, classification, and communication, is vital for children aged 5-8, influencing their understanding of science content. However, SPS proficiency is reportedly low in some Indonesian regions, emphasizing the need to focus on learning process skills in inclusive education. The traditional approach of information delivery limits students' engagement and hindered skill development, leading to reduced motivation and accomplishment. DI is proposed as a relevant strategy to enhance the science process skills of students with ID in inclusive elementary school.

Methods

This study used qualitative methods with a case study design. Using a case study approach (Nasir et al., 2022), researchers can explore experiences and perspectives from various related parties, such as teachers and pupils, with a view to identifying factors that influence the success or failure of DI implementation in learning SPS for ID pupils in inclusive primary schools (Yin, 2018; Wang et al., 2021). The research took place over a period of four months, spanning from January to May 2023.

Data in this study were collected using interview protocols and documents. The interview protocols were designed with open-ended questions to facilitate the free and in-depth expression of respondents. The interview questions can be indicated in Table 1.

Table 1

Interview questions

Aspects	Question	Duration
Interview		
Application of DI	Tell us about your experience applying DI in science learning for ID pupils.	1 hour per respondent
SPS enhancement	How do you assess the science process skills of ID pupils after applying the DI?	
Challenge	What are some of the challenges you face in implementing DI in science learning for ID pupils?	

The sampling procedure in this study was purposive. The population was teachers in inclusive primary schools. From that population, 5 teachers were randomly selected. This study used observation sheet instruments, interview sheets, and teacher-prepared documents (Merriam & Tisdell, 2015). This interview included a discussion of lesson plan, implementation related to lesson plan, and content of material taught. Through this interview, the aim was to gain a deeper understanding of teacher preparation in planning and executing learning, as well as understanding the approaches and strategies used in teaching and evaluating students. Observation was carried out to directly observe the DI process carried out by the teacher in the classroom. The process of data analysis in study used thematic analysis. The data was analysed to identify key themes that emerged from interviews (Noble & Heale, 2019).

Findings

Teacher readiness in applying DI

The results presented in this research offer a summary of teacher preparedness and instructional methods in implementing Differentiated Instruction (DI) in primary schools, as outlined in Table 2.

Table 2

Teacher readiness theme

Aspects	Challenges	Frequency of study respondents				
		R1	R2	R3	R4	R5
Teacher pedagogy	Readiness of teacher pedagogy in DI		x	x		x
Learning plan	Lesson implementation plan guidelines in accordance with DI principles for ID students	x	x		x	
Valuation system	Revision of the SPS scoring system in DI			x	x	x

Below are instances demonstrating the preparedness of teachers to implement Differentiated Instruction (DI).

How do you see the challenges in improving teacher pedagogy capabilities and learning innovation training, especially in the context of inclusive education?

> *"I need DI guidelines and supportive teaching materials. Even though we have implemented DI, it is still not right with the SPS needs of ID pupils because of my limited ability to facilitate DI. We feel that we still need further debriefing."* (R2)
>
> *"I have attended DI training, but not optimally, because only in general, not specific to children with special needs"* (R3)
>
> *"Implementing DI requires skills that we have not fully mastered. So I still find it difficult to implement it, as much as I can, one of which is accommodating children based on readiness, but for the others I still explain"* (R5)

Have you created a lesson plan that contains DI principles?

> *"I still have difficulty in making a DI implementation plan, because specific examples for pupils with special needs are still limited, especially IR pupils."* (R1)
>
> *"I made the learning implementation plan simple by containing one of the DI principles, namely continuous assessment, but sometimes it is not realised in the learning process, because I do not fully understand the technique"* (R2)
>
> *"I made it, but it's not good [haha], because I'm confused about integrating it, with such time and the DI principle, I can't adjust yet, unless there are guidelines"* (R4)

How do you plan a science process skills assessment system in different instructional contexts?

> *"I realise some pupils need different assessments to achieve SPS moreover SPS will be more appropriate if formative assessments are based on process, but it will take a long time to have to prepare different assessments for each student, so I use the final results through multiple-choice question tests"* (R3)
>
> *"The SPS assessment system that I do is not consistent, sometimes I use tests, sometimes I use observations of activities that pupils do. The form of assignment is still the same for all pupils, but the assessment results are differentiated according to student ability especially ID pupils, it is certain that the score is lower than other students"* (R4)

"I made it in the form of a test at the end of the lesson, because ID pupils are more likely to be passive" (R5)

Table 3 explains the lesson plan used by the teacher.

Table 3

Lesson plan

Subjects	Information
Subject	Changes in the shape of objects
Class	V
Competency standards	Understand and explain the concept of deformation of objects
Achievement indicators	1. Identify the main components in an object. 2. Analyse changes in the shape of objects. 3. Demonstrate an understanding of the changing shape of objects
Learning steps	1. Introduction: - A brief introduction to the concept of deformation of objects. - Introduction activities through open-ended questions and short discussions. 2. Core learning: -Class discussion on the concept of changing the shape of objects. - Case study analysis of changes in the shape of objects. - Small group activities to discuss changes in the shape of objects. 3. Field Activities: - Field trips to the school garden for observation of types of objects. 4. Project assignment: - Pupils are given the task of making a small project in the form of an experiment on an object.

Skills to Process Differentiated Science Learning for ID Students

Teacher expertise plays a crucial role in the successful execution of DI, however not all educators possess equal proficiency in this regard, despite the acknowledgment from respondents regarding their competence in DI management. The findings in this study describe teacher skills in the differentiated science learning process for ID students described in Table 4.

Table 4

Teacher skills managing learning

Aspects	Challenge	Frequency of study respondents				
		R1	R2	R3	R4	R5
Attention of the teacher	Teacher initiative in dealing with ID pupils in DI	x				
Teacher's perception	Teacher's perception of DI			x		
Teacher reception	Emotions regulation				x	
Teacher's attitude	Teacher's enthusiasm in processing DI		x			

"Um, it still needs adjustments to apply DI to the learning environment of ID pupils, because so far only regular pupils have been accommodated, while ID pupils must be more given guidance in every activity" (R1)

"The implementation of DI in class sometimes does not match the lesson implementation plan that I have made, adjusting the conditions and situations of pupils. If you want to differentiate, of course there must be supporting resources." (R3)

"In handling students with intellectual disabilities (ID) during learning sessions, it's essential to exercise additional patience, particularly when they frequently seek assistance. Sometimes, meeting each

pupil individually can be exhausting. Consequently, I endeavour to foster collaboration among students, encouraging them to support each other and work collectively during lessons." R4
"I think DI is good to be applied in the learning environment of inclusive primary school pupils, until now I am still trying to continue to learn to understand different pupils, especially ID pupils so as not to be neglected again in class." (R4)

Learning Resources that Facilitate DI in Pupil SPS

The aspects asked regarding Learning Resources available to teachers are as follows contained in Table 5.

Table 5

Learning resource used in DI

Aspects	Challenge	Frequency of study respondents				
		R1	R2	R3	R4	R5
Availability	The available learning resources can meet the needs in DI					x
Quality	Learning resources are accurate, relevant and interesting to learners.				x	
Conformity	Available learning resources must match science learning objectives (SPS)	x				

"The available learning resources use book teaching materials facilitated by the Ministry of Education, Culture, Research, and Technology, as well as from the internet. If asked whether it meets or not, of course not, the teaching materials available are still general, not differentiated for the needs of each pupil." (R5)
"The learning resources used today are more appropriate if used by pupils with normal development, the content and activities emphasise critical thinking, so they are less relevant when used by ID pupils." (R4)
"The learning objectives and activities of SPS are appropriate, but the level of difficulty is not relevant to the learning objectives for ID pupils." (R1)

Discussion

Our initial discovery pertains to teacher preparedness in utilizing DI. According to the findings, enhancing teacher competencies is pivotal in establishing a learning environment that accommodates pupil diversity effectively. Training in learning innovations focused on new strategies and differential teaching methods is a crucial step to ensure teachers can more effectively respond to the unique needs of each learner. There is a requirement for special endeavours to align lesson implementation plan guidelines more closely with DI principles, particularly for students with special needs, specifically those with special needs (IR). Clear guidelines are needed that guide teachers in identifying and designing lesson plans that can be tailored to students' individual ability levels and learning styles. Furthermore, the revision of the school assessment system is also a crucial aspect that needs to be in line with DI principles. A DI-compliant assessment system can provide a more accurate picture of a student's progress and provide support for their individual development. To implement these changes, concrete steps such as regular teacher training programs, the development of inclusive learning guidelines, and revisions to assessment systems that consider the diversity of students'

abilities are needed. Cooperation between schools, government, and evaluation teams is essential in providing resources and supporting this transformation process. Through this joint effort, it is hoped that a learning approach that accommodates the needs of diverse students, improves the quality of education, and ensures equal access to education for all.

Regarding the skills required to facilitate differentiated science learning for ID students, our research identified the critical importance of teacher attention, perception, reception, and attitude. The study findings underscore the intricate dynamics involved in teachers' endeavours to support students with ID within the framework of DI. ID students necessitate more intensive guidance, underscoring significant disparities in learning requirements between typical students and those with ID. This prompts inquiries regarding the readiness of learning environments to address these needs and underscores the necessity for more inclusivity-focused strategies to be developed. Simultaneously, the presence of a disconnect between planning and implementation underscores the influential role played by factors related to the student's condition and circumstances. Engaging students in the planning and execution phases, such as in extracurricular endeavours, has the potential to cultivate favourable attitudes and enhance the overall well-being of the school environment (Jägerbrink et al., 2022). Furthermore, the absence of supportive resources underscores the necessity for increased investment in facilities and tools that facilitate differentiated approaches. Hence, it is imperative to identify and implement policy changes and allocate resources accordingly to enable teachers to effectively implement DI.

The emotional aspects of teachers opened a window into the personal challenges they faced in dealing with ID students. The extra patience, the adjustment of roles from simply providing instruction to being a more active companion, and the teacher's efforts to create collaboration among students demonstrate the complexity of inclusive classroom dynamics. Teacher emotional management becomes an important element in maintaining a positive and supportive learning environment and emphasizes the importance of emotional and mental support for educators involved in this context. Studies have underscored the importance of teachers' emotional regulation and interpersonal demeanour when interacting with these students (Alevriadou & Pavlidou, 2015). Teachers' attitudes toward inclusive education, particularly regarding students with emotional and behavioural disorders and intellectual disabilities, have a significant influence on the efficacy of inclusive practices (Moberg et al., 2019). Teachers need to be encouraged and empowered through training, collaboration, and empowerment that can strengthen their passion and commitment to DI implementation. Therefore, a holistic and collaborative approach is needed to ensure that every student, including those with special needs, has a meaningful and inclusive learning experience.

In the context of Instructional Differentiation (DI), findings from interviews show that the available learning resources, have not fully met the needs of each student. Respondents stated that the teaching materials available are still general, not differentiated for the needs of each student. This highlights the importance of developing more differential teaching materials in order to accommodate students' individual learning needs in inclusive classrooms. Further, interviews with Respondent 4 revealed the mismatch of learning resources used today to the needs of ID pupils. Learning resources tend to be more appropriate if used by students with normal development, emphasizing aspects of critical thinking. However, this lack of relevance creates a mismatch in supporting the learning needs of IR students. Therefore, there is a need for adjustments and revisions to learning resources to ensure relevance to the special needs of ID students.

From the point of view of science learning objectives (SPS), the interview with Respondent 1 highlighted the difference in the difficulty level of learning resources with learning objectives. Although SPS learning objectives and activities are considered appropriate, difficulty levels irrelevant to ID students are a concern. This indicates the need for adjustments to the difficulty level of learning resources to match the abilities of ID learners. To improve the effectiveness of DI, next steps may involve the development of more differential teaching materials, teacher training in selecting and adapting learning resources, curriculum review, and close collaboration between teachers and education specialists.

The findings highlight several critical implications for teachers working with ID pupils in inclusive primary schools. Firstly, there is a pressing need for enhanced teacher readiness in implementing DI, particularly regarding planning learning experiences tailored to the specific needs of ID students. Secondly, teachers should focus on developing teaching materials that are appropriately aligned with the abilities and learning styles of ID pupils, which may require additional training and resources. Thirdly, addressing the lack of DI-related teacher training and coaching in inclusive primary schools is crucial for improving the efficacy of DI implementation. These implications underscore the importance of ongoing professional development and support for teachers to effectively meet the diverse needs of ID students in inclusive educational settings.

The study presents several notable limitations that warrant careful consideration. Firstly, the relatively small sample size may restrict the applicability of the study findings to a wider population. Researchers are encouraged to expand the sample size to enhance the study's generalizability, which could be achieved through conducting multicentre studies or collaborating with multiple institutions to access larger and more diverse participant pools. Additionally, it is crucial to recognize the limitations inherent in the instruments used for data collection, as well as the potential for bias introduced by researchers during both data collection and interpretation phases. Researchers should thoroughly assess and possibly refine the data collection instruments to mitigate inherent limitations and enhance measurement validity. Moreover, efforts should be made to address potential biases introduced during data collection and interpretation by implementing rigorous research methodologies, such as blinding procedures or independent validation of findings. Furthermore, the study solely relies on interview data, which may restrict the breadth and depth of insights obtained from alternative sources or methodologies. These limitations emphasize the importance of exercising caution when interpreting the study findings and suggest avenues for future research to mitigate these constraints and bolster the reliability of conclusions drawn. To address the reliance on interview data, future studies could integrate complementary data sources or methodologies, such as observational studies or quantitative surveys, to offer a more comprehensive understanding of the research topic.

Conclusion

The findings indicated persistent challenges for teachers in implementing Differentiated Instruction (DI) for ID students in science subjects within inclusive primary schools. Despite endeavours to comprehend and apply DI, teacher preparedness remains constrained, particularly concerning: 1) orchestrating learning implementation tailored to the requirements of ID students; 2) devising teaching materials aligned with the capabilities of ID students; and 3) insufficiency of DI-focused teacher training and mentoring in inclusive primary school settings. A major obstacle in DI implementation is related to the limited availability of resources, which hinders the provision of individualized support and customized instructions. Therefore, efforts to overcome these obstacles are essential in creating an effective inclusive learning environment. In addition, the study found that assessment practices in inclusive schools were less consistent in applying the DI approach to evaluating the abilities of students with intellectual disabilities in SPS. Inconsistent application of DI in assessment hinders accurate and inclusive assessment of this student's progress and ability. These findings provide valuable insights into the challenges that exist in inclusive primary schools in Indonesia. It emphasizes the need for modification of learning models that prioritize the unique needs of intellectually disabilities students. In addition, overcoming resource constraints and improving the implementation of DI strategies within the SPS framework can be considered an important step towards developing an inclusive learning environment. To improve educational experiences and outcomes for intellectually underdeveloped students in SPS, education stakeholders, including school administrators, policymakers, and teachers, should focus on developing and implementing flexible curricula. Adequate allocation of resources and consistent application of DI approaches in assessment

should also be prioritized to ensure accurate evaluation and inclusive support for these students. By addressing these identified limitations and promoting inclusive practices, inclusive primary schools can create an environment that can support the learning and development of students with intellectual retardation, enabling them to thrive academically and reach their full potential.

The study's findings have significant implications for inclusive schools, emphasizing the need for flexible learning and provision of DI to intellectually disabilities students within the SPS framework. To achieve this, it is important to allocate sufficient resources and maintain consistency in the implementation of the DI during assessment and evaluation. The study highlights the importance of scaling up inclusive approaches and promoting learning development among students with intellectual retardation. By incorporating DI within the SPS framework, inclusive schools can effectively support these students in acquiring and honing their science process skills. Based on the research findings, several recommendations can be made. First, it is imperative to provide support to inclusive schools in designing learning models that facilitate the implementation of DI within the SPS framework. Second, adequate resources, both human and material, must be allocated to support the implementation of DI. Teachers should receive appropriate training and professional development to enhance their knowledge and skills in applying DI techniques effectively. This will enable them to meet the unique needs of intellectually disabilities students, promoting an inclusive and effective learning environment. In addition, it is important to maintain consistency in the application of DI during assessment and evaluation. This ensures that the abilities and progress of IR students within the SPS framework are assessed accurately and inclusively. Consistency in assessment practices allows educators to track the growth and development of these students, providing valuable insights for further support and intervention. By implementing these recommendations, inclusive schools can create an environment that fosters academic success and the overall well-being of students with intellectual retardation, promoting inclusive education and equitable opportunities for all learners.

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References

Alevriadou, A., & Pavlidou, K. (2015). Teachers' interpersonal style and its relationship to emotions, causal attributions, and type of challenging behaviors displayed by students with intellectual disabilities. *Journal of Intellectual Disabilities*, *20*(3), 213–227. https://doi.org/https://doi.org/10.1177/1744629515599108

Algozzine, B., & Anderson, K. M. (2010). Tips for teaching: Differentiating instruction to include all students. *Preventing School Failure: Alternative Education for Children and Youth*, *51*(3), 49–54. https://doi.org/10.3200/PSFL.51.3.49-54

Alkharraz, R. A. A.-R. (2022). Inclusion from the perspective of inclusive education and special education. *Rimak International Journal of Humanities and Social Sciences*, *04*(04), 67–87. https://doi.org/10.47832/2717-8293.18.4

Applefield, J. M., Huber, R., & Moallem, M. (2001). Constructivism in theory and practice: toward a better understanding on jstor. *The High School Journal*, *84*(2), 35–53. https://doi.org/10.2307/40364404

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215. https://doi.org/10.1037/0033-295X.84.2.191

Barbra, M., & Joyline, N. (2014). The inclusion of children with mental disabilities: A teacher's Perspective. *International Journal of Humanities Social Sciences and Education (IJHSSE)*, *1*(2), 65-75.

Bhakti, Y. B., Agustina, I., & Astuti, D. (2018). The Influence Process of Science Skill and Motivation Learning with Creativity Learn. *Journal of Education and Learning (EduLearn)*, *12*(1), 30–35. https://doi.org/10.11591/edulearn.v12i1.6912^30

Carlberg, C., & Kavale, K. (2016). The efficacy of special versus regular class placement for exceptional children: A meta-analysis. *The Journal of Special Education*, *14*(3), 295–309. https://doi.org/10.1177/002246698001400304

Castiblanco, V., Pelaez, L., Santana, M., & Lengua, D. T. (2023). How do teachers differentiate instruction through materials in a Colombian rural zone? *Lengua y Sociedad.*, *22*(2), 283–302. https://doi.org/https://doi.org/10.15381/lengsoc.v22i2.25216

Chakravartty, A. (2023). Scientific knowledge vs. Knowledge of science: Public understanding and science in society. *Science and Education*, *32*(6), 1795–1812. https://doi.org/10.1007/s11191-022-00376-6

Chiappetta, E. L., & Koballa, T. R., Jr. (2010). *Science instruction in the middle and secondary schools: developing fundamental knowledge and skills for teaching* (6th ed.). Pearson Inc. https://doi.org/9780131916562

Cologon, K. (2020). Is inclusive education really for everyone? Family stories of children and young people labelled with 'severe and multiple' or 'profound' 'disabilities. *Research Papers in Education*, *37*(3), 395–417. https://doi.org/10.1080/02671522.2020.1849372

Comarú, M. W., Lopes, R. M., Braga, L. A. M., Batista Mota, F., & Galvão, C. (2021). A bibliometric and descriptive analysis of inclusive education in science education. In *Studies in Science Education* (Vol. 57, Issue 2, pp. 241–263). Routledge. https://doi.org/10.1080/03057267.2021.1897930

Corby, D., King, E., Petrie, M., Reddy, S., Callan, A., & Andersen, T. (2022). Making a case for the Inclusion of people with intellectual disabilities in higher education. *Disabilities*, *2*(3), 415–427. https://doi.org/10.3390/disabilities2030029

Çoruhlu, T. Ş., Çalık, M., Nas, S. E., & Bilgin, B. (2023a). Improving science process skills of students with mild intellectual disabilities. *Journal of Baltic Science Education*, *22*(2), 323–336. https://doi.org/10.33225/jbse/23.22.323

Çoruhlu, T. Ş., Çalık, M., Nas, S. E., & Bilgin, B. (2023b). Improving science process skills of students with mild intellectual disabilities. *Journal of Baltic Science Education*, *22*(2), 323–336. https://doi.org/10.33225/jbse/23.22.323

Dalgaard, N. T., Bondebjerg, A., Viinholt, B. C. A., & Filges, T. (2022). The effects of inclusion on academic achievement, socioemotional development and wellbeing of children with special educational needs. In *Campbell Systematic Reviews* (Vol. 18, Issue 4). John Wiley and Sons Inc. https://doi.org/10.1002/cl2.1291

Daniel, D., Nastiti, A., Surbakti, H. Y., & Dwipayanti, N. M. U. (2023). Access to inclusive sanitation and participation in sanitation programs for people with disabilities in Indonesia. *Scientific Reports*, *13*(1), 1-12. https://doi.org/10.1038/s41598-023-30586-z

Darmaji, Kurniawan, D. A., Astalini, Perdana, R., Kuswanto, & Ikhlas, M. (2020). Do a science process skills affect on critical thinking in science? Differences in urban and rural. *International Journal of Evaluation and Research in Education*, *9*(4), 874–880. https://doi.org/10.11591/ijere.v9i4.20687

Demir, S. (2021). The effects of differentiated science teaching according to the grid model. *Pegem Journal of Education and Instruction*, *11*(4), 147–159. https://doi.org/10.47750/pegegog.11.04.14

Dewi, C. A., & Rahayu, S. (2023). Implementation of case-based learning in science education: A systematic review. *Journal of Turkish Science Education*, *20*(4), 729–749. https://doi.org/10.36681/tused.2023.041

Dunn, R., & Dunn, K. (2018). Differentiated instructional strategies: One size doesn't fit all. Corwin. https://doi.org/10.4135/9781483330243

Faisal, & Martin, S. N. (2019a). Science education in Indonesia: Past, present, and future. *Asia-Pacific Science Education*, *5*(1), 1–29. https://doi.org/10.1186/s41029-019-0032-0

Faisal, & Martin, S. N. (2019b). Science education in Indonesia: Past, present, and future. *Asia-Pacific Science Education*, *5*(1), 1–29. https://doi.org/10.1186/s41029-019-0032-0

Fidler, D. J., Schworer, E., Swanson, M., & Hepburn, S. (2022). Intellectual disability. *The Cambridge Handbook of Intelligence*, 241–257. https://doi.org/10.1017/9781108770422.012

Hanreddy, A., & Östlund, D. (2020). Alternate curricula as a barrier to inclusive education for students with intellectual disabilities. *International Electronic Journal of Elementary Education*, *12*(3), 235–247. https://doi.org/10.26822/iejee.2020358217

Hasanah, E., Suyatno, S., Maryani, I., Badar, M. I. Al, Fitria, Y., & Patmasari, L. (2022). Conceptual model of differentiated-instruction (DI) based on teachers' experiences in Indonesia. *Education Sciences*, *12*(10), 1-17. https://doi.org/10.3390/educsci12100650

Hidayat, R., Wan Idris, W. I., Qudratuddarsi, H., & Abdul Rahman, M. N. (2021). Validation of the mathematical modeling attitude scale for Malaysian mathematics teachers. *Eurasia Journal of Mathematics, Science and Technology Education, 17*(12), 1-16. https://doi.org/10.29333/ejmste/11375

Hidayat, R., & Wardat, Y. (2023). A systematic review of Augmented Reality in Science, Technology, Engineering and Mathematics education. *Education and Information Technologies, 29*(8), 9257–9282. https://doi.org/10.1007/s10639-023-12157-x

Hornby, G. (2015). Inclusive special education: development of a new theory for the education of children with special educational needs and disabilities. *British Journal of Special Education*, *42*(3), 234–256. https://doi.org/10.1111/1467-8578.12101

Idris, N., Talib, O., & Razali, F. (2022). Strategies in mastering science process skills in science experiments: A systematic literature review. *Jurnal Pendidikan IPA Indonesia*, *11*(1), 155–170. https://doi.org/10.15294/jpii.v11i1.32969

Ingram, C. P. (1941). Difficulties in the classification of children who are intellectually backward. *Journal of Educational Psychology*, *32*(6), 365–379.

Irwanto, Rohaeti, E., & Prodjosantoso, A. K. (2018). Undergraduate students' science process skills in terms of some variables: A perspective from Indonesia. *Journal of Baltic Science Education*, *17*(5), 751–764. https://doi.org/10.33225/JBSE/18.17.751

Jägerbrink, V., Glaser, J., & Östenberg, A. H. (2022). Extracurricular pulse activities in school: students' attitudes and experiences. *International Journal of Environmental Research and Public Health*, *19*(22), 1-11. https://doi.org/https://doi.org/10.3390/ijerph192215051

Jonker, H., März, V., & Voogt, J. (2020). Curriculum flexibility in a blended curriculum. *Australasian Journal of Educational Technology*, *36*(1), 68–84. https://doi.org/10.14742/AJET.4926

Kala, N., & Ayas, A. (2023). Effect of instructional design based on cognitive load theory on students' performances and the indicators of element interactivity. *Journal of Turkish Science Education*, *20*(3), 468–489. https://doi.org/10.36681/tused.2023.027

Kamila, H. R., Cahyaningrum, S. E., & Sanjaya, I. G. M. (2023). Effectiveness of differentiated learning materials oriented toward nature of science to improve scientific literacy skills. *Jurnal Penelitian Pendidikan IPA*, *9*(4), 1968–1973. https://doi.org/10.29303/JPPIPA.V9I4.2995

Kaymakcı, G., & Can, Ş. (2021). Investigation of the effects of some variables on middle school students' problem-solving skills, science process skills and learning styles. *Educational Policy Analysis and Strategic Research*, *16*(1), 394–426. https://doi.org/10.29329/epasr.2020.334.21

Kim, D. (2023). Analysis of peer relationships in Korean middle school inquiry and noninquiry science experiment classes. *Journal of Turkish Science Education*, *20*(1), 10–25. https://doi.org/10.36681/tused.2023.002

Krämer, S., Möller, J., & Zimmermann, F. (2021). Inclusive education of students with general learning difficulties: A meta-analysis. *Review of Educational Research*, *91*(3), 432–478. https://doi.org/10.3102/0034654321998072

Larison, K. D. (2022). On beyond constructivism: Using intersubjective approaches to promote learning in the science classroom. *Science and Education*, *31*(1), 213–239. https://doi.org/10.1007/S11191-021-00237-8

Lawal, Suleiman, & Mfr, I. (2022). Implementation of inclusive education in nigerian schools: challenges and way forward. *International Journal of Formal Education*, *01*(03), 32–41. https://doi.org/doi.org/10.17605/osf.io/92tck

Lawrence-Brown, D. (2020). Differentiated instruction and inclusive schooling. *Oxford Research Encyclopedia of Education*, *1*(1223), 1–10. https://doi.org/10.1093/ACREFORE/9780190264093.013.1223

Lennox, N. G., Diggens, J. N., & Ugoni, A. M. (1997). The general practice care of people with intellectual disability: barriers and solutions. *Journal of Intellectual Disability Research: JIDR*, *41 (Pt 5)* (5), 380–390. https://doi.org/10.1111/J.1365-2788.1997.TB00725.X

Lindner, K. T., & Schwab, S. (2020). Differentiation and individualisation in inclusive education: a systematic review and narrative synthesis. *International Journal of Inclusive Education*, *25*(4), 371–393. https://doi.org/10.1080/13603116.2020.1813450

Liu, P. (2021). Applying differentiated instruction in elementary classrooms: practice and reflection of student teachers. *Journal of Education and Practice*, *12*(27), 1–11. https://doi.org/10.7176/JEP/12-27-01

Maeng, J. L., & Bell, R. L. (2015). Differentiating science instruction: secondary science teachers' practices. *International Journal of Science Education*, *37*(13), 2065–2090. https://doi.org/10.1080/09500693.2015.1064553

Maulida, E. (2019). Lesson of inclusive education implementation in Jakarta: Availability and accessibility issues. *Education Quarterly Reviews*, *2*(1), 172-184. https://doi.org/10.31014/aior.1993.02.01.51

Mcginnis, J. R. (2013). Teaching science to learners with special needs on JSTOR. *Iversity and Equity in Science Education*, *52*(1), 43–50. https://doi.org/10.1080/07351690.2013743776

Mendoza, M., & Heymann, J. (2022). Implementation of inclusive education: A systematic review of studies of inclusive education interventions in low- and lower-middle-income countries. *International Journal of Disability, Development and Education*, 71(3), 299–316 https://doi.org/10.1080/1034912X.2022.2095359

Moberg, S., Muta, E., Korenaga, K., Kuorelahti, M., & Savolainen, H. (2019). Struggling for inclusive education in japan and finland: teachers' attitudes towards inclusive education. *European Journal of Special Needs Education*, *35*(1), 100–114. https://doi.org/https://doi.org/10.1080/08856257.2019.1615800

Molefe, L., & Aubin, J. B. (2021). Exploring how science process skills blend with the scientific process: Pre-service teachers' views following fieldwork experience. *South African Journal of Education*, *41*(2), 1-13. https://doi.org/10.15700/saje.v41n2a1878

Mutlu, M., & Kağan Temız, B. (2013). *Educational Research and Reviews Science process skills of students having field dependent and field independent cognitive styles*. *8*(11), 766–776. https://doi.org/10.5897/ERR2012.1104

Nasir, S. N. C. M., Alias, Z., Jaffar, S. F., & Hidayat, R. (2022). Rural secondary teachers' readiness to teach online in the pandemic era: A case study. *Mathematics Teaching Research Journal, 14*(3), 80-94. https://files.eric.ed.gov/fulltext/EJ1361575.pdf

Noble, H., & Heale, R. (2019). Triangulation in research, with examples. In *Evidence-Based Nursing 22*(3), 67–68. BMJ Publishing Group. https://doi.org/10.1136/ebnurs-2019-103145

Özgelen, S. (2012). Students' science process skills within a cognitive domain framework. *Eurasia Journal of Mathematics, Science and Technology Education*, *8*(4), 283–292. https://doi.org/10.12973/eurasia.2012.846a

Pakombwele, A., & Tsakeni, M. (2022). The teaching of science process skills in early childhood development classrooms. *Universal Journal of Educational Research*, *10*(4), 273–280. https://doi.org/10.13189/ujer.2022.100402

Pozas, M., Letzel, V., & Schneider, C. (2020). Teachers and differentiated instruction: exploring differentiation practices to address student diversity. *Journal of Research in Special Educational Needs*, *20*(3), 217–230. https://doi.org/10.1111/1471-3802.12481

Pratono, A., Sumarti, S., & Wijayati, N. (2018). Contribution of assisted inquiry model of e-module to students science process skill. *Alamat Korespondensi: Jl. Maluku No*, *7*(1), 62-68. http://journal.unnes.ac.id/sju/index.php/jise

Roldán, S. M., Marauri, J., Aubert, A., & Flecha, R. (2021). How inclusive interactive learning environments benefit students without special needs. *Frontiers in Psychology*, *12*, 1-12 661427. https://doi.org/10.3389/FPSYG.2021.661427

Rusmini, Suyono, & Agustini, R. (2021). Analysis of science process skills of chemical education students through self-project based learning (SJBL) in the covid-19 pandemic era. *Journal of Technology and Science Education*, *11*(2), 371–387. https://doi.org/10.3926/JOTSE.1288

Sabah, S., Akour, M. M., & Hammouri, H. (2023). Implementing next generation science practices in classrooms: findings from TIMSS 2019. *Journal of Turkish Science Education*, *20*(2), 309–319. https://doi.org/10.36681/tused.2023.017

Sanger, C. S. (2020). Inclusive pedagogy and universal design approaches for diverse learning environments. *Diversity and Inclusion in Global Higher Education*, 31–71. https://doi.org/10.1007/978-981-15-1628-3_2/COVER

Sen, K., & Shahi, S. (2021). *Creating a culture of diversity and inclusiveness in India.* Springer Nature Singapore. https://doi.org/https://doi.org/10.1007/978-981-16-4237-1

Şenel, Ç. T., Er-Nas, S., Çalık, M., Ergül, C., Çepni, S., & Karagöz, G. N. (2022). The effectiveness of the experimental guidebook on the science process skills of students with mild mental disabilities. *Ankara University Journal of Special Education Faculty*, *23*(4), 230-243. https://doi.org/https://doi.org/10.21565/ozelegitimdergisi.826644

Sheehy, K., Budiyanto, Kaye, H., & Rofiah, K. (2019). Indonesian teachers' epistemological beliefs and inclusive education. *Journal of Intellectual Disabilities*, *23*(1), 39–56. https://doi.org/10.1177/1744629517717613/asset/Images/large/10.1177_1744629517717613-FIG4.JPEG

Sholahuddin, A., Yuanita, L., Supardi, Z. A. I., & Prahani, B. K. (2020). Applying the cognitive style-based learning strategy in elementary schools to improve students' science process skills. *Journal of Turkish Science Education*, *17*(2), 289–301. https://doi.org/10.36681/tused.2020.27

Sibic, O., & Sesen, B. acar. (2022). Examining science process skills tests: A case of Turkey. *International Journal of Assessment Tools in Education*, *9*(1), 20–38. https://doi.org/10.21449/IJATE.1058055

Sideri, A., & Skoumios, M. (2021). Science process skills in the greek primary school science textbooks. *Science Education International*, *32*(3), 231–236. https://doi.org/10.33828/sei.v32.i3.6

So, W. W. M., He, Q., Chen, Y., Li, W. C., Cheng, I. N. Y., & Lee, T. T. H. (2022). Engaging students with intellectual disability in science, technology, engineering, and mathematics learning. *Science Education International*, *33*(1), 25–37. https://doi.org/10.33828/sei.v33.i1.3

Solé-Llussà, A., Aguilar, D., & Ibáñez, M. (2022). The effect of an instructional intervention based on the use of video-worked examples to promote elementary students' science process skills. *International Journal of Education in Mathematics, Science and Technology*, *10*(3), 753–772. https://doi.org/10.46328/ijemst.2158

Sujana, I. M., & Wayan Puniawati, I. A. (2020). 21st century learning skills in teaching learning cycles. *Scientific Journal of the Education Profession*, *5*(1), 15–28. https://doi.org/10.29303/jipp.v5i1.101

Suwastini, K. A. (2021). Differentiated instruction across EFL classrooms: a conceptual review. *TELL-US Journal*, *7*(1), 14–41. https://doi.org/10.22202/tus.2021.v7i1.4719

Tomlinson, C. A. (2001). *How to differentiate instruction in mixed-ability classrooms*. Association for Supervision and Curriculum Development. http://www.ascd.org

Tomlinson, C. A., & Eidson, C. C. (2003). *Differentiation in practice: a resource guide for differentiating curriculum, grades K-5*. Association for Supervision and Curriculum Development. http://www.ascd.org

Tosun, C. (2022). Bibliometric and content analyses of articles related to science education for special education students. *International Journal of Disability, Development and Education*, *69*(1), 352–369. https://doi.org/https://doi.org/10.1080/1034912X.2021.2016659

Trilling, B., & Fadel, C. (2009). *21st century skills: Learning for Life in our times* (1st ed.). Jossey bass. https://doi.org/10.5860/choice.47-5788

Utami, A., Sujarwo, Fauziyah, P. Y., Mustadi, A., Hidayat, R., & Rofiki, I. (2024). Bibliometric analysis of research developments on differentiated instruction. *European Journal of Educational Research, 13*(3), 1421-1439. https://doi.org/10.12973/eu-jer.13.3.1421

Vantieghem, W., Roose, I., Gheyssens, E., Griful-Freixenet, J., Keppens, K., Vanderlinde, R., Struyven, K., & Van Avermaet, P. (2020). Professional vision of inclusive classrooms: A validation of teachers' reasoning on differentiated instruction and teacher-student interactions. *Studies in Educational Evaluation*, *67,* 1-12. https://doi.org/10.1016/J.STUEDUC.2020.100912

Wang, S., Chen, M., Li, M., Liu, Y., & Ye, X. (2021). Research on the presentation methods of moocs' teaching video based on the qualitative research approached: A case study of 322 National-level quality MOOCs. *Open Journal of Social Sciences*, *09*(10), 368–379. https://doi.org/10.4236/JSS.2021.910026

Williams, C. A., Bailey, T., & Hastings, R. P. (2022). Modelling triadic relationships in families of children with intellectual disability. *Journal of Applied Research in Intellectual Disabilities*, *35*(3), 843–855. https://doi.org/10.1111/JAR.12988

Wilson, N. J., Jaques, H., Johnson, A., & Brotherton, M. L. (2017). From social exclusion to supported inclusion: adults with intellectual disability discuss their lived experiences of a structured social group. *Journal of Applied Research in Intellectual Disabilities*, *30*(5), 847–858. https://doi.org/10.1111/JAR.12275

Wilujeng, I., Suryadarma, I. G. P., Ertika, & Dwandaru, W. S. B. (2020). Local potential integrated science video to improve SPS and concept mastery. *International Journal of Instruction*, *13*(4), 197–214. https://doi.org/10.29333/iji.2020.13413a

Woodcock, S., Sharma, U., Subban, P., & Hitches, E. (2022). Teacher self-efficacy and inclusive education practices: Rethinking teachers' engagement with inclusive practices. *Teaching and Teacher Education*, *117,* 1-12. https://doi.org/10.1016/j.tate.2022.103802

Yin, R. K. (2018). *Case study research* (*Sixth edition*). SAGE. https://doi.org/10.4135/9781526430212.n21

Zulueta, L. F., & Panoy, J. F. D. (2022). Scenario-based microlearning strategy for improved basic science process skills in self-directed learning. *International Journal of Science, Technology, Engineering and Mathematics*, *2*(4), 54–73. https://doi.org/10.53378/352932