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ORIGINAL ARTICLE

Science Teachers' Experiences to Ensure Science for All Movement: from Theory to Practice

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ABSTRACT

The principle of Science for All emphasizes that every learner, including students with disabilities (SWD), should have equitable opportunities to access and participate in science education. This study explores how science teachers in inclusive schools in the Indonesian context design, present, and assess science lessons based on universal design for learning and the index for inclusion. Using a qualitative approach, data were collected from 25 science teachers across 16 schools through interviews and classroom observations, and were analyzed thematically with attention to trustworthiness. Findings reveal that lesson planning was often identical for SWD and their peers, with limited modifications; however, disability-specific adaptations (e.g., visual scaffolds for hearing loss, audio/tactile resources for low vision, and structured routines for students with autism and cognitive disabilities) improved accessibility. In lesson presentation, individualized approaches, activity-based tasks, and varied media increased participation, though resource limitations sometimes reduced practices to simple demonstrations. Assessment remained the least developed domain, with heavy reliance on written exams; yet project-based tasks, multimodal feedback, extended time, and the involvement of shadow teachers (learning support assistants) provided fairer alternatives. The study highlights both progress and gaps in realizing inclusive science education, in which, while teachers improvise accommodations, practices remain inconsistent without systemic training and support. These findings underscore the urgency of strengthening teacher preparedness and aligning institutional policy with classroom realities to transform Science for all from principle into practice in developing contexts.

KEYWORDS: Inclusive science education, index for inclusion, science for all, science for students with disabilities, universal design for learning

INTRODUCTION

"The notion of "science for all" suggests that all students, irrespective of achievement and ability, should engage in opportunities to understand the practice and discourse of science" (Villanueva and Hand, 2011, p. 233). Therefore, in the last 15 years, approaches to teaching science for students with disabilities (SWD) have become a frequently discussed topic (Comarú et al., 2021), along with the increasing number of SWD in regular classes. They have the right to the same education, including science education (Comarú et al., 2021; Donegan-Ritter, 2017).

Science education has a broader aim and is an essential part of life development (Brigham et al., 2011; Holbrook, 2010). Scientific knowledge and skills also play an important role in an individual's ability to live independently in society (Rizzo and Taylor, 2016) and adapt to environmental changes that occur. Therefore, science education is important for all children, including SWD.

Implementing inclusive practices in learning in developing countries (e.g., Indonesia) continues to encounter various challenges and obstacles (Sharma et al., 2013). For instance, the representation of SWD in science classes in Indonesia is still low, making it difficult for SWD to succeed in effective science learning. This is due, in part, to teachers using a one-size-fits-all curriculum. The learning environment for science learning is not accessible, such as the use of traditional teaching methods (Behzad and Prabha, 2017; Magdalena et al., 2020), delivery of material that is less accessible (Logan et al., 2020; Wulayalin and Suprihatiningrum, 2024), lack of accommodation for active learning (Logan et al., 2020), discussions, and practicals that do not accommodate the needs of people with disabilities (Leah and Kayla, 2008), as well as a lack of assistive technology (Kamran and Bano, 2024). SWD also often face language barriers, especially in understanding special science vocabulary (Langley-Turnbaugh et al., 2009; Susannah et al., 2020; VanUitert et al., 2022), so they are limitedly involved in discussions and scientific investigations. These conditions cause SWD's participation and achievement of science learning outcomes not to be as good as other students (Mutch-Jones et al., 2012).

Effective science learning for SWD occurs if the learning provided can accommodate the diversity of students' needs (Villanueva et al., 2012). This includes the curriculum being easily accessible, learning objectives appropriately designed, and support by materials, methods, and assessments that are

diverse, flexible, and responsive (Hitchcock et al., 2002) or as called inclusive learning. One framework that can be used to design, monitor, and evaluate inclusive science learning practices is the universal design for learning (UDL) (Hansen et al., 2016).

UDL is a pedagogical framework that applies Universal Design principles in practice by fostering a social model of disability in the design of learning environments (Marino et al., 2014; Nieminen and Pesonen, 2019). UDL helps teachers provide various options to students to convey scientific understanding (Basham and Marino, 2013), alternative teaching methods for all students (Meyer et al., 2014), and student access and involvement in learning (Capp, 2017), where SWD's involvement in learning is very minimal because they are considered incapable (Abell et al., 2011). UDL promotes the idea that accessible learning environments will not be based on individual adjustments (the medical model) but will be based on an inclusive design that benefits all students (not only aimed at SWD) (Nieminen and Pesonen, 2019).

In the context of science learning, UDL allows teachers to provide the accessibility support needed by SWD, such as support for students with sensory or motor limitations and students who are not fluent in reading and arithmetic. UDL can support a collaborative science learning environment. For example, when students find a hypothesis, students are encouraged to convey or discuss the hypothesis explicitly, supported by justification or reasons and existing evidence (Finnegan and Dieker, 2019). In addition, UDL emphasizes using contextual supports to assist students in developing effective science learning (Rappolt et al., 2013).

In addition to UDL, inclusivity can be designed using the index for inclusion (IFI) guidelines developed by the Center for Studies on Inclusive Education. IFI explains that barriers to learning and participation are not only experienced by SWD but by all students (Hick, 2005), so to be inclusive, schools should not focus on the failures of SWD but rather on how to overcome the barriers to learning and participation encountered by each student (Allister, 2005; Mark, 2002). Inclusivity in IFI is explored with three dimensions: creating an inclusive culture, producing inclusive policies, and developing inclusive practices (Ainscow et al., 2006; Booth and Ainscow, 2002). These dimensions encourage creating an inclusive school environment by providing a community that accepts and respects everyone (Alborno and Gaad, 2014; Brokamp, 2017), reaching all students, learning that is responsive to the diversity of students, and actively involving students in every aspect of education (Booth and Ainscow, 2002).

Although numerous investigations have been conducted on science learning for SWD, they remain limited in scope, especially in Indonesia. Research on inclusive science education is still less developed compared to special education contexts (Comarú et al., 2021). Addressing this gap, the present study explores how science teachers create environments where diverse learners can thrive through adapted and modified instruction, content, and assessment using UDL and IFI principles. Specifically, the study seeks to answer the research question: How do science teachers in inclusive schools design, present, and assess science lessons to ensure "Science for All" for SWD, based on the principles of UDL and IFI?

METHODS

Study Design

This research employed a qualitative descriptive approach to explore science teachers' practices in inclusive classrooms. The study was conducted in 16 Schools Providing Inclusive Education across the DI Yogyakarta Province, Indonesia. These schools were selected because they officially implement inclusive policies by admitting SWD into regular classrooms. The context of a developing nation is also crucial, as inclusive practices face systemic and resource-related challenges that differ from those in high-income countries.

Participants and School Context

Twenty-five science teachers participated in this study, representing junior high schools (grades 7–9) and senior high schools (grades 10–12). The sample included public and private schools and schools in both urban and semi-urban areas. Teacher participants taught various subjects, including science, biology, physics, and chemistry. The participants had between 1 and 24 years of experience in teaching SWD. Table 1 summarizes the demographics of the participating schools and teachers.

Data Collection

Data were collected over 6 months using semi-structured interviews and classroom observations. Each teacher was interviewed 2–3 times, lasting 60–90 min per session. The interviews followed semi-structured guidelines aligned with UDL and IFI principles. Questions focused on lesson planning, instructional strategies, and assessment practices for SWD. Table 2 provides an overview of the core interview questions.

Data Analysis

A content analysis approach was applied. Interview transcripts were coded inductively and deductively. Initial codes were generated based on interview questions (aligned with UDL and IFI domains), while emergent themes were identified through iterative reading. Coding proceeded in three stages: Open coding (identifying significant statements from transcripts), axial coding (grouping related codes into categories [e.g., planning, presentation, assessment]), and thematic coding (developing overarching themes and sub-themes across categories). The analysis process was supported by cross-checking among the research team to enhance inter-coder agreement.

Classroom observations played a critical role in triangulating findings. While interviews captured teachers' perspectives and reported strategies, observations showed how lesson plans, instructional modifications, and assessments were enacted in practice. Observational data were particularly valuable in

Table 1: Teacher participants

School code	School type	Grade levels	Names (pseudonym)	Genders	Subject taught	Experiences of teaching SWD (years)
A	Public	7	Audrey	F	Science	>1
		8	Aster	F	Science	>5
		8	Helena	F	Science	>3
		7	Danica	F	Science	>3
B	Public	8	Amber	F	Science	>1
		8	Juliet	F	Science	>1
		7	Luna	F	Science	>5
		7	Kate	F	Science	>5
C	Public	10	Mellisa	F	Science	>5
D	Public	11	Willy	F	Chemistry	±24
E	Public	10	Monica	F	Biology	>1
F	Private	11	Michael	M	Science	>5
G	Public	10	Elizabeth	F	Science	>4
H	Private	10	Kimberly	F	Physics	>2
I	Public	11	Rachel	F	Science	>2
J	Private	10	Nancy	F	Science	>1
K	Private	10	Mac	M	Science	±4
L	Public	11	Dee	F	Chemistry	±4
M	Private	10	Nora	F	Science	>1
N	Private	7	Rose	F	Science	>5
		8	Leticia	F	Science	>5
O	Private	7	Tata	F	Science	>5
		8	Irene	F	Science	>5
P	Public	8	Maria	F	Science	>15
		9	Sofia	F	Science	>5

SWD: Students with disabilities

Table 2: Sample interview questions

Domain	Sample question
Lesson Planning	How do you identify and accommodate the needs of SWD when preparing lesson plans?
Instruction	What teaching strategies do you use to ensure that all students can access content?
Assessment	How do you adapt assessments for SWD? How do you monitor the learning progress of SWD?

SWD: Students with disabilities

confirming consistency between teachers' claims and their classroom actions and revealing nuances that were not always articulated in interviews (e.g., body language, peer support, use of assistive media). These insights were integrated into the results and discussion sections to provide a richer and more valid account of inclusive science teaching practices.

Trustworthiness

Several strategies were applied to ensure the findings' credibility, dependability, and transferability. Credibility was supported through member checking, in which interview summaries were returned to participants for confirmation, and triangulation that combined interviews and classroom observations. Dependability was maintained by keeping a detailed audit trail documenting the coding process, decision-making, and data management. Transferability was enhanced by providing rich contextual descriptions of schools, teachers, and classroom practices so that readers could judge the applicability to other contexts. Finally, confirmability was strengthened by keeping reflexive notes to minimize researcher bias in interpreting the data.

RESULTS AND DISCUSSION

This section presents findings on how science teachers plan, present, and assess inclusive science learning for SWD, guided by UDL and IFI. To improve transparency and readability, we report evidence distribution per (sub) theme using counts of schools/teachers that contributed data, as shown in Table 3.

Lesson Planning

Science teacher participants mainly devised lesson plans for SWD that were identical to those established for their peers. However, some participants adjusted the lesson plans to accommodate the SWD's needs. The way they accommodated the SWD is:

Identifying student needs

Most science teachers (Schools A, D, E, F, H, K, L) identified students' needs before the semester began. Aster (School A) mentioned that I usually observe children before entering class by asking the homeroom and shadow teachers. That way, I have ideas of how the learning will be, especially for SWD. They have additional and special needs that we should address. Having detailed information on SWD helps me modify the curriculum.

Table 3: Theme map with distribution

Theme	Sub-theme	Source	Distribution
Lesson Planning	Identifying student needs	Interviews	7 schools (A, D, E, F, H, K, L)
	Collaboration with shadow teachers/colleagues	Interviews	8 schools (A, C, D, N, F, G, K, P)
	Considering SWD abilities in learning outcomes	Interviews	3 schools (A, B, N)
	Using UDL to design lessons	Interviews	2 schools (A, J)
Lesson Presentation	Individual approach	Interviews	7 schools (A, B, C, D, G, L, P)
	Detailed instructions	Interviews	4 schools (A, D, H, I)
	Activity-based learning (e.g., SCL, hands-on, real-world contexts)	Interviews and Observations	Reported across sites; explicitly at multiple schools; mnemonics at B, O; hands-on/demos at A, J, M, P
	Varied methods/media (audio, visual, small groups, assistive supports)	Interviews	Explicitly at A, N, B (and others)
Lesson Assessment	Modified tasks/difficulty	Interviews	Multiple schools, incl. F, A, L
	Lowering passing grade	Interviews	Multiple schools (e.g., G, B)
	Additional time	Interviews	R, M, H, L, M (teachers Rose, Melissa, Kimberly, Dee, Nora)
	Timely feedback	Interviews	G, K
	Shadow teacher assistance	Interviews	D, (others)

SWD: Students with disabilities, UDL: Universal design for learning, SCL: Student-centered learning

Leticia (School N) stated, "Curriculum modification is needed based on the students' needs … We should understand what they need, and then the lessons will be applicable."

Identifying SWD's needs at the beginning of the semester emerged as a foundational step for inclusive planning. Teachers used information from homeroom and shadow teachers to anticipate accommodations, showing that proactive identification is critical to curriculum modification.

Collaboration with shadow teachers and colleagues

After needs identification, teachers in many schools (A, C, D, N, F, G, K, P) coordinated with shadow teachers, aligning on progress, constraints, and resources as indicated by Willy (School D). Shadow teachers facilitate our school to help SWD. They usually come every Friday. On Fridays, I am sometimes accompanied by the shadow teacher to coordinate and discuss student progress and any challenges they face. This information will then be used as a reference for preparing lesson plans for the following topics.

Similarly, Maria (School P) expressed that shadow teachers are valuable resources during planning.

Collaboration with shadow teachers provided teachers with essential insights into SWD progress and barriers. This reliance indicates that inclusive lesson planning often depends on external expertise, reflecting both the potential and fragility of collaborative arrangements in contexts where teachers lack prior preparation.

Considering abilities in learning outcomes

A few participants (Schools A, B, and N) considered SWD's abilities (particularly cognitive abilities) when planning the lessons. Danica mentioned, "We cannot determine the learning outcomes for SWD that are the same as their peers. Many of them have below-average cognitive abilities. This is what we must consider when creating learning outcomes." Amber (School B) believed that SWD could effectively engage with the educational material provided, despite the congruence in learning outcomes with other students. In contrast, Leticia (School N) elucidated, "I maintained consistency in the learning goals; it should be the same for all, yet those students could actively participate in the class following the same lesson plans."

Teachers displayed contrasting approaches. Some lowered expectations for students with cognitive disabilities, while others insisted on maintaining common goals. This reveals an ongoing tension between equity (tailoring expectations) and equality (uniform outcomes) in inclusive lesson planning.

Using the UDL framework to design lessons

Only Schools A and J reported explicit UDL-based lesson design. Aster (School A) explained, Plans are made one for all students. In the past, there was a learning plan for SWD, namely IEP, but it was removed because it was not inclusive… Now I know how to create lessons that accommodate all students, how to modify expected learning outcomes, and how to select appropriate learning strategies.

Nancy (School J) also confirmed, "Inclusive science learning will not work without a few modifications… We got this from UDL training."

Only a few teachers, mainly those exposed to training, explicitly used UDL principles. Their practices highlighted the potential of UDL for designing single plans that accommodate all learners, yet the limited uptake underscores the need for systematic professional development.

Planning for specific disability

For hearing loss, teachers often integrated visual materials, placed students at the front of the class, and sometimes collaborated with sign-language interpreters. For low vision, teachers relied on audio explanations and tactile or hands-on activities, such as using models or real objects, to help students grasp abstract concepts. For students with ASD and cognitive

disabilities, planning emphasized breaking tasks into smaller steps, establishing predictable routines, and allowing flexible outcomes tailored to individual capacities.

Critical reflection on inclusive lesson planning

Lesson planning emerges as the crucial entry point for realizing Science for All. UDL encourages teachers to adapt goals and strategies to their students' varied strengths, abilities, and motivations, so that all can actively engage and feel challenged (Almeqdad et al., 2023; Basham and Marino, 2013). Prior studies emphasize that tailoring outcomes and making targeted adjustments promotes inclusion and prevents disengagement (Gregg, 2007; Hogan, 2005; Johnson-Harris and Mundschenk, 2014; Meier and Rossi, 2020).

The findings indicate that most teachers still prepare identical lesson plans for SWD and their peers, with limited modifications. Where adaptations did occur, such as Aster's and Nancy's application of UDL training, they were highly dependent on external support and training, underscoring that systematic professional development is needed to embed inclusive planning consistently (Basham and Marino, 2013; Meyer et al., 2014). The reliance on shadow teachers (i.e., learning support assistants) during planning, as described by Willy and Maria, also reflects the central role of collaborative expertise in contexts where teachers often lack prior preparation in inclusive education. These findings highlight that while teachers recognize the need to adapt, the capacity to design genuinely inclusive plans is uneven and fragile.

Notably, the data illustrate how planning differs by disability type. Teachers emphasized visual scaffolds and seating for hearing loss, audio/tactile resources for low vision, and task chunking or predictable routines for ASD and cognitive disabilities. These strategies align with previous studies highlighting that visual scaffolds improve access for hearing-impaired learners (Capp, 2017), while tactile and contextualized learning enhance comprehension for low-vision students (Villanueva et al., 2012). Similarly, structured routines and task chunking are recognized as practical approaches for students with ASD (Marino et al., 2014). Such differentiation prevents overgeneralization across SWD categories and underscores that inclusive planning requires disability-specific and universal strategies.

The contrast between Danica's lowered expectations for students with cognitive disabilities and Leticia's insistence on common goals reflects the ongoing tension between equity and equality in inclusive planning. Thus, lesson planning in this study demonstrates both progress and gaps; teachers are beginning to incorporate UDL principles, but efforts remain limited and inconsistent without broader institutional capacity. Inclusive planning, therefore, must move beyond general modifications toward evidence-based, disability-sensitive strategies that balance common learning goals with individualized pathways for participation.

Lesson Presentation

Participants implemented various strategies to facilitate students' learning needs and build inclusive classrooms.

Individual approach

Schools A, B, C, D, G, L, and P adopted individualized support, particularly for students with sensory disabilities. Kate (School B) explained, We can get closer to that student [with a learning difficulty] and give clear directions on where she is lacking. For the students with hearing loss, we only rely on lip reading. When our articulation is clear, she usually understands what we say. I cannot use sign language. Therefore, I gave her many notes to ensure she understood the lessons. I also put her in the first row, hoping she could catch my lip reading.

Individual approaches ensured more direct support, but strategies were often limited to adjustments like seating arrangements and more precise articulation, without deeper instructional redesign.

More detailed instructions

Science teachers in Schools A, D, H, and I provided more detailed instructions to support SWD. Audrey shared, I offer different methods of instruction. For that student [with hearing loss], I instruct him in very detail and slowly, step by step. Sometimes, I add pictures to provide him with more visualization. I want all my students to have equal access to learning regardless of their different approaches to learning.

Helena reinforced this: "To be more independent, the instructions must be very thorough, more detailed than others, or we can even give them our own directions, and it works."

Providing explicit, step-by-step instructions reduced barriers for SWD and promoted independence, but it required additional teacher effort and visual scaffolding.

Activity-based learning

All participants reported implementing activity-based or student-centered learning (SCL) to support autonomy and participation. Monica emphasized, "SCL is very important, especially when implementing the Emancipated Curriculum. With this approach, I can more accurately assess students' creativity in solving the problems I give them." Similarly, Elizabeth (School G) highlighted that SCL enabled her low-vision students to express their needs more confidently.

Teachers also used varied methods to activate participation. Luna (Schools B) created mnemonics: "For electronic configuration, I made sentences to memorize to make it easier to grasp the material." Juliet (School B) engaged students with real-world observation: "I asked students to leave the classroom to observe plants… an ASD student was very interested and very focused." She also connected lessons to current phenomena: "For example, they learn about viruses, and I connected this to the trending topic of COVID-19… They seem more attracted to learning when familiar with the topic."

Hands-on activities were also common. Danica (School A) explained that demonstrations, simulations, and practicums

captured SWD's attention. Helena reinforced: "Hands-on science learning is usually a more visual method, starting from practice or through observation in nature, using a microscope in the laboratory." Nancy (School J) incorporated projects such as disaster mitigation tasks, noting, "This assignment allows students to be creative freely in visual and audio form… it will also increase hands-on activity."

When time or resources were limited, simpler experiments or demonstrations replaced complete practicals. Nora (School M) said, "I use a simple experiment to teach students the chemical change of chemical reaction and electrolyte solution." Due to limited time and material, Sofia (School P) and Luna (School B) relied on demonstrations.

Activity-based approaches promoted active participation and confidence, particularly when lessons were contextualized. Yet, constraints often reduced practices to simplified demonstrations rather than full experiential learning.

Variations of learning methods and media

Teachers also varied methods and media to increase inclusivity. Helena (School A) explained, "For the blind, we select audio-based resources… For students with hearing loss, it has to be a lot of visuals… We also use a small group to activate the students' participation." Rose (School N) highlighted UDL. The UDL framework helps us find a way to offer multiple strategies and varied media so that every student learns at their own pace… We have a shadow teacher who helped us as a sign language interpreter. She helps students with hearing loss acquire information. She also helps autistic students learn in their own way, using prompting and chunking.

Juliet (School B) described how varied activities benefited autistic students: "This child really likes studying biology because it often gives her the opportunity to share opinions, make presentations, observe surroundings, and do simple experiments."

Varied media and group strategies aligned with UDL principles, but mainly remained at the accommodation level. The role of shadow teachers further extended accessibility.

Critical reflection on inclusive lesson presentation

These findings indicate that science teachers employed diverse strategies, individual approaches, detailed instructions, activity-based learning, and varied media to enhance the participation of SWD. While these practices echo UDL's principle of providing multiple means of engagement and representation (Capp, 2017; Meyer et al., 2014), they remain predominantly accommodations rather than substantive modifications of pedagogy. This reflects what Lindner and Schwab (2020) found that teachers often equate inclusion with accessibility measures, without rethinking the core of instruction.

A critical issue is the tendency to generalize across disability categories. In this study, teachers adapted lessons differently for students with hearing loss (visual scaffolds, lip reading, sign-language interpreters), low vision (audio-based narration, tactile resources), and ASD (structured routines, contextual activities). Such differentiation is crucial, as research shows that targeted supports are more effective than generic strategies (Marino et al., 2014; Villanueva et al., 2012). Recent studies (Lindner and Schwab, 2020; Nieminen and Pesonen, 2019) similarly emphasize that inclusive pedagogy must address distinct cognitive, sensory, and socioemotional profiles rather than treating SWD as a homogeneous group.

The data also illustrate that activity-based and real-world strategies (e.g., projects, contextual observation, and mnemonics) resonate with findings that experiential and situated learning increase motivation and conceptual understanding for SWD. In particular, project-based science has fostered engagement and collaboration among learners with diverse needs, as this also noted by Schwab et al. (2020). However, resource constraints pushed some teachers to rely on simple demonstrations, underscoring systemic inequities common in developing contexts (Forlin and Chambers, 2011; Sharma et al., 2013). The uneven availability of assistive technology and professional support further limited implementation, mirroring Loreman's (2017) observation that inclusivity often depends on school-level resources rather than systemic provision.

Therefore, a paradox emerges: teachers demonstrate creativity in varying methods and media, yet their practices remain fragmented and inconsistently aligned with UDL or DI principles. Inclusive lesson presentation risks being ad hoc rather than transformative without sustained professional learning. A recent study argues that teacher training must combine disability-specific knowledge with universal frameworks like UDL to avoid surface-level inclusion (Navaitienė and Stasiūnaitienė, 2021). In Indonesia, where an inclusive education policy exists but implementation is uneven, this study highlights the urgent need for capacity-building programs that enable teachers to accommodate and redesign lesson delivery for diverse learners.

Lesson Assessment

Science teacher participants modified assessments depending on disability type, support level, and assessment form.

Modifying assignments and difficulty level

Almost all participants adjusted assignments for SWD. Michael (School F) said, Because those SWDs have limitations, I always try to make adjustments for the assessment, such as simplifying the language in the questions. I made questions in pictures because I have Deaf students, and they responded to the questions well.

Amber (School A) reflected on her autistic student, I am surprised that the autistic student's grade was not as expected… I then realized that she couldn't express her understanding in writing… I modified the assignment into another format that she could perform. I offered to present something related to the topic.

Audrey (School A) added, "SWD loves working with Quizzes, Kahoot, Slido… The apps have many variations that we can modify as needed." Aster described how School A combined exams and interdisciplinary projects (IDU), "We have projects and written examinations… We adjust the project to the student's abilities."

Dee (School L) also emphasized alternatives: "The written assignment is used for cognitive assessment. However, it does not always measure students' abilities accurately. Therefore, I provided an alternative… Some made posters and IG posts, while others submitted the regular report."

Teachers modified assignments differently depending on disability type: Visual-based questions for Deaf students, oral or project outputs for ASD learners, and alternative products for students with cognitive difficulties. These adaptations aligned assessments with diverse abilities.

Lowering the passing grade

Most teachers lowered the science passing grade for SWD. Elizabeth (School G) explained, "SWD have a different cognitive level from others, so it is necessary to adjust the grading and the passing grade so that the assessments applied will be fairer and more realistic."

Juliet (School B) added, Some teachers thought he was smart… Then, I was surprised that his grades were so bad on the final exam. I then discussed this with colleagues, and we decided to lower his passing grade. We did this to all SWD.

This strategy was mainly applied to students with cognitive disabilities. While it was seen as promoting fairness, it also risked masking deeper learning challenges.

Providing additional time

Some teachers (Rose, Melissa, Kimberly, Dee, and Nora) allowed SWD more time to complete tasks. Rose explained, "I gave them group project assignments but with different time submissions for each student, and I thought it was beneficial for SWD."

Extra time was particularly important for students with cognitive disabilities and ASD, offering them more processing time and reducing stress.

Offering timely feedback

Elizabeth (School G) emphasized feedback: "I always offer students a variety of ways to get my feedback… I provide voice notes for students with visual impairments and small notes for students with hearing loss."

Mac added, "Effective feedback using a collaborative approach means questions are not always directed at the teacher; Interactive quizzes like Quizzes can be used to get feedback on which parts students have not mastered yet."

Feedback was tailored by disability type, that is, voice notes for low-vision students, written notes for Deaf students, and interactive quizzes for ASD learners. These multimodal approaches supported continuous reflection and improvement.

Collaborating with a shadow teacher

Willy (School D) described collaboration:

> For the final exam, I gave the worksheet to be checked by the shadow teacher… Shadow teachers usually accompany those students to work on exam questions. For the students with visual impairment, the shadow teacher helped them read the questions… For students with hearing loss and autism, the shadow teacher prompted the questions.

Shadow teachers functioned differently depending on disability. They read aloud and recorded answers for low-vision students, adapted or prompted questions for Deaf and ASD students, and advised teachers on assessment modifications.

Critical reflection on inclusive lesson assessment

Overall, the assessment strategies observed were creative but limited in scope. Teacher participants relied heavily on written exams, which often disadvantaged SWD. Alternatives such as projects, oral presentations, and technology-based tasks reflected a shift toward what Ofiesh et al. (2006) and Lazarus et al. (2022) call universal assessment, where multiple means of action and expression allow students to demonstrate understanding. A culturally responsive assessment proposed by Levy-Feldman (2025) can also be an alternative to inclusive assessment.

Differentiating assessment practices by disability type proved essential. Adaptations for Deaf students centered on visual supports, low-vision students on auditory modalities, for ASD students on oral or project-based outputs, and for those with cognitive disabilities on grading adjustments and time extensions. These align with UDL principles (Basham and Marino, 2013; Capp, 2017), but their application was inconsistent across schools. Adjusting grades, while intended as fairness, echoes debate in the literature about whether such practices promote equity or dilute expectations (Estayan et al., 2024; Wakeman et al., 2021).

The active role of shadow teachers resonates with Malizal and Rizqi (2025); Suprihatiningrum et al. (2022), Eliza Putri et al. (2024) highlighting the importance of collaborative adaptation. However, as in lesson planning and presentation, many practices remain surface-level accommodations rather than deeper redesigns of assessment systems. To move beyond this, teachers need training on designing varied assessments aligned with both curriculum goals and disability profiles. Therefore, enhancing teacher preparedness is essential for moving beyond ad hoc adjustments toward more consistent and systemic inclusive assessment practices.

CONCLUSION

The Science for All movement shows great promise, but this study reveals that significant challenges still exist in creating inclusive science classrooms. Most teachers still develop identical lesson plans for SWD and their peers, making only minimal adjustments. Only a few teachers, like Aster and Nancy, reported explicitly using UDL after receiving targeted

training, highlighting the need for ongoing professional development to implement inclusive design consistently. In addition, planning varied depending on the disability type, teachers used visual scaffolds for hearing loss, tactile or audio resources for low vision, and chunked tasks for ASD or cognitive disabilities, indicating that disability-specific adjustments are possible but not always applied uniformly.

In lesson presentation, teachers used individualized approaches, activity-based tasks, and various media, strategies that align with UDL's call for multiple means of engagement. For example, Elizabeth noted that SCL increased her low-vision students' confidence, while Juliet shared how contextual tasks engaged her autistic student. These practices show the benefits of differentiated strategies. However, in several schools, resource constraints reduced teaching to simple demonstrations, which often caused disengagement among SWD. This suggests that inclusive presentation is not optional but crucial for equitable participation.

Assessment practices were the least developed area. Teachers primarily depended on written exams, which put many SWD at a disadvantage, especially those with cognitive disabilities. Some participants explored alternatives like projects (Aster, Dee), multimodal assignments (Amber), extended time (Rose), or multimodal feedback (Elizabeth). Shadow teachers, serving as learning support assistants, played a vital role in modifying exams for Deaf, low-vision, and autistic students to ensure fairness. These findings highlight that project-based and differentiated assessment, aligned with UDL's principle of multiple means of action and expression, offer fairer ways to measure achievement compared to standard written tests.

Overall, the findings reveal both progress and gaps. Teachers are experimenting with inclusive practices, but many efforts remain inconsistent and reliant on external support. Realizing Science for All, therefore, requires systemic investment in teacher training, school-level collaboration, and accessible resources. For Indonesia, where the latest curriculum already promotes differentiated instruction, this study emphasizes the urgent need to translate policy into practice. More broadly, by explicitly linking lesson planning, presentation, and assessment to UDL and IFI principles, this study provides evidence from a developing-nation context that inclusion is not only a pedagogical choice but a systemic necessity. It demonstrates that equitable science education for SWD depends on moving from ad hoc accommodations toward coherent, disability-sensitive strategies that can inform teacher education, curriculum design, and national policy.

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