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Cognitive Task Analysis Against the Low Implementation of Data-Based Instructional Design in Kindergarten Teachers' Differentiated Learning Practices

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Abstract
The main objective of this study is to analyze the cognitive barriers that underlie the limited transformation of assessment data into proactive instructional design in the practice of Differentiated Instruction (DI) among Kindergarten teachers. The method used is descriptive qualitative with a Cognitive Task Analysis (CTA) approach to uncover expert decision-making processes that are often implicit. The research subjects involved 31 expert teachers from 31 districts/cities in Indonesia, with data collected through STAR essays, practice video recordings, and structured interviews. The analysis was carried out using the parameters of the DI 4:9:2 skill formula, which included the preparation, implementation, and evaluation phases. The results of the study revealed a significant phenomenon of "practice fragmentation"; Although 42% of kindergarten teachers routinely conduct pre-assessments, only 3% use them to determine learning objectives and materials. Teachers showed high dominance in reactive differentiation through the provision of additional support (90.32%) but very low dominance in proactive adaptation of instruction (26%). These findings suggest a cognitive barrier in "data translation" skills in the preparatory phase, where assessment is often only an administrative formality, rather than a pedagogical foundation. The main recommendation of this study is to reorient the teacher professional development program from merely a data-collection tool to one that strengthens skills in assessment-based instructional design. In addition, strengthening Learning Communities is highly recommended to facilitate the sharing of cognitive strategies and "rules of thumb" to bridge the gap between assessment data and adaptive learning planning.

Keywords: differentiation; cognitive task analysis; learning preferences; expert teachers

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INTRODUCTION

Differentiated instruction (DI) is widely recognized as the instructional gold standard for promoting educational equity in heterogeneous classrooms (Coubergs et al., 2017; Valiandes, 2015). DI requires teachers to modify content elements, processes, products, and learning environments based on diagnostic data on students' readiness, interests, and learning profiles (Dack, 2019; Tomlinson et al., n.d.; van Geel et al., 2019). Although its urgency has become a mandate in national curriculum policies, the implementation of DI remains one of the most complex teaching tasks, demanding high-level professional skills (Frerejean et al., 2021; Meutstege et al., 2023).

Although theoretically promising, the effectiveness of DI is still shrouded in controversy in the global literature. On the one hand, research reports a significant positive impact on student achievement (Pozas et al., 2020a, 2020b; Valiandes, 2015). On the other hand, some studies have found inconclusive results, even warning of potential negative effects for low-ability students if differentiation focuses solely on grouping without the adaptation of high-quality instruction. This uncertainty points to a crucial gap in understanding how assessment data should be accurately translated into classroom instructional design (Deunk et al., 2018; Roy et al., 2015).

The gap in translating assessment data is most acute at the local level, especially in Early Childhood Education. The urgency of this research stems from findings on the phenomenon of "practice fragmentation," which is particularly pronounced at the kindergarten level (Juwita, Sukmawati, Budhi Santosa, et al., 2025; Juwita, Sukmawati, Santosa, et al., 2025). The latest primary data reveal that although as many as 42% of kindergarten teachers routinely conduct pre-assessments, this figure has plummeted to only 3% for using this data to determine learning objectives and material selection. Existing pre-assessment instruments have also failed to detect misconceptions, underscoring the need to develop more comprehensive diagnostic instruments (Asnidar et al., 2026).

This condition is particularly urgent to investigate because it shows that early assessments at the kindergarten level often amount to mere administrative formalities on paper, while teaching remains reactive. Without proactive instructional design, kindergarten teachers tend to rely on spontaneous "additional support" (90.32%) but fail to make planned "instructional adaptations" (only 26%) (Juwita et al., 2024; Juwita, Sukmawati, Budhi Santosa, et al., 2025; Juwita, Sukmawati, Santosa, et al., 2025). If cognitive gaps in translating these assessment data are not identified immediately, then the implementation of DI at the early childhood education level risks failing to provide the right challenges for students, ultimately leaving them outside the *Zone of Proximal Development* (Juwita, Sukmawati, Santosa, et al., 2025; Meutstege et al., 2023).

To unravel these hidden cognitive barriers, this follow-up research introduces a novel approach by applying *the Cognitive Task Analysis* (CTA) method. This method was chosen because it can capture expert knowledge that is often implicit or unrealized (Clark et al., 2008; van Geel et al., 2019). This research is a follow-up study that aims to analyze how CTA can reveal the reasons behind the low rate of transformation of assessment data into instructional design in kindergarten teachers' practice. The proposed working hypothesis is that the low implementation is due to cognitive barriers in "data translation" skills in the preparation phase. The main parameter measured was mastery of the prerequisite DI skills, based on the 4:9:2 skills formula, which included the preparation, implementation, and evaluation phases. Based on previous research, implementing DI requires mastery of the systematic skill set outlined in the 4:9:2 formula, identified through *the Cognitive Task Analysis* (CTA) method to capture the in-depth knowledge and decision-making strategies used by expert teachers (Frerejean et al., 2021; Juwita, Sukmawati, Santosa, et al., 2025; van Geel et al., 2019). This formula divides a total of 15 prerequisite skills into three main phases: four skills in the preparation phase which include setting learning objectives, identifying student needs (pre-assessment), determining grouping techniques, and selecting teaching materials; nine skills in the implementation phase which include goal delivery, initial knowledge activation, provision of adapted instruction, provision of grouping options, material variation, clear explanations, tiered questioning, incremental (proactive) support, and flexibility of working time; as well as two skills in the evaluation phase which involve providing opportunities for students to demonstrate understanding in their own way and providing a variety of assessment options. Through CTA analysis, this study proposes a working hypothesis that low implementation in the field is rooted in cognitive barriers in specific "data translation" skills in the preparation phase, where pre-assessment outcome data have not been consistently transformed into proactive instructional design before teachers enter the classroom (Frerejean et al., 2021; van Geel et al., 2019).

Based on this background and urgency, this research is guided by the following research questions:

1. To what extent do kindergarten teachers represent the mastery of the prerequisite knowledge of DI based on the 4:9:2 formula (RQ 1)?
2. What specific cognitive barriers prevent kindergarten teachers from transforming assessment data into proactive instructional design (RQ 2)?
3. How do kindergarten teachers cognitively bridge the gap between the implementation of pre-assessment and the design of learning objectives and materials (RQ 3)?
4. What are the rules *of* thumb that guide the formation of a final DI instructional model that is ready for adoption in the Learning Community (RQ 4)?

METHODS

This study uses a descriptive qualitative approach to explore teachers' experiences in implementing DI. The main method used is Cognitive Task Analysis (CTA), a technique designed to capture both explicit and implicit knowledge that experts use when executing complex instructional tasks. The use of CTA in this study aims to illuminate the cognitive decision-making process, often overlooked by experienced teachers (Clark et al., 2008; Sullivan et al., 2023).

The research subjects comprise 31 expert teachers from 31 districts/cities in Indonesia who are participants in the 2025 Teacher Appreciation event. The initial pool of 31 participants was selected from the 2025 Annual Teachers' Appreciation, representing educators who are strongly committed to professional development. However, the designation of "expert teachers" was reserved for a sub-sample identified through a purposive sampling process based on specific objective criteria. Each STAR essay was evaluated by a panel of educational experts using a standardized rubric. To be considered an "expert" for the structured interviews and video submissions, a teacher's essay had to meet three thresholds: (1) Instructional Alignment, where learning objectives were clearly derived from identified student needs; (2) Pedagogical Sophistication, demonstrating at least two concurrent forms of differentiation (e.g., content and process); and (3) Evidence of Impact, documenting specific improvements in student engagement or social inclusiveness. The top 10 essays from each school level that met these criteria were selected, ensuring the findings reflect high-level pedagogical reasoning.

The analysis focused in depth on a subsample of kindergarten teachers to examine the uniqueness of their cognitive structure compared with other levels. Data was collected through a variety of instruments: (1) STAR (*Situation, Task, Action, Result*) format self-essay to explore teachers' past behaviors; (2) Video recording of teaching practices to capture authentic data and mitigate unnatural behavior due to direct observation; and (3) Structured interviews and Expert Meetings to verify and deepen the findings.

Data Analysis Stages Data analysis follows the five stages of CTA according to Clark's framework (table 1):

1. Initial Knowledge Gathering (STAR Literature and Essay Study)
   The first phase focused on collecting baseline initial knowledge about DI across the entire target population (all teachers). The main instrument used in this phase is the STAR (*Situation, Task, Action, Result*) essay. Through this instrument, all participants were asked to reflect and narrate their real experiences in planning and implementing learning based on mapping students' needs. The textual data from this STAR essay were combined with a systematic literature review of the 4:9:2 skill formula to establish the study's initial theoretical parameters.
2. Identification of Knowledge Representations (DI Skill Concept Mapping)
   In the second stage, data from all teachers were analyzed to identify how they represented instructional knowledge in the mental schema. The researcher conducted concept *mapping* based on the elements of DI skills in the 4:9:2 formula. This step aims to measure the extent to which teachers' cognitive structure, in general, aligns with the 15 prerequisite skills, divided into the preparation, implementation, and evaluation phases. The mapping results at this stage are used to identify specific cognitive barriers, particularly practice fragmentation, in which pre-assessment data are not translated into instructional design.
3. Focused Knowledge Elicitation (Video Analysis and *Cued-Recall* Interviews)
   Once cognitive barriers were mapped out in general, the study moved to the third stage by narrowing the subjects to a group of participants categorized as selected/expert teachers. The elititution of in-depth knowledge was carried out using two main techniques: (1) video recording analysis of teachers' teaching performance in the classroom, and (2) *cued-recall* interviews based on the video stimulus. Expert teachers are asked to reconstruct the reasoning behind each instructional decision they make during the video's preparation and implementation phases. This process triggers teachers to verbalize *implicit knowledge* and problem-solving strategies that are usually unknown when teaching.
4. Data Analysis and Verification (Systematic Coding)
   The fourth stage involves a rigorous qualitative analysis of *cued-recall* interview transcripts and expert-teacher video recordings. The data were parsed using *a systematic coding* technique based on verbatim transcripts to summarize,

classify, and synthesize the cognitive information obtained. The data verification process is carried out through *the member checking* method with selected teachers to ensure that the resulting codes truly represent their cognitive architecture and instructional decisions. This step is crucial for extracting the cognitive rules of thumb that distinguish expert teachers from other teachers.

5. Result Formatting (DI Model Preparation for PLC)
In the final stage, all findings on cognitive processes, barriers successfully bridged, and *rules of thumb* from expert teachers were formatted and synthesized into a final instructional model of DI. This model integrates the 4:9:2 formula with practical, field-tested cognitive guidance. The outputs of this stage are specifically designed to be operational, applicable, and ready for adoption and dissemination within the Professional Learning Community (PLC) ecosystem to improve data-based instructional adaptation competence among other kindergarten teachers.

The qualitative data from the STAR (Situation, Task, Action, Result) essays and structured interviews were systematically processed using a technique known as "quantitising," which provides a descriptive overview of the prevalence of specific behaviors within the qualitative sample. The analysis followed a deductive coding approach using the 4:9:2 skill formula (consisting of 15 constituent skills) as a predetermined framework. Each participant's data corpus (essay, interview transcript, and video) was coded for the presence or absence of these specific skills. If a teacher explicitly described or demonstrated a skill, such as "conducting pre-assessment," it was recorded as a binary frequency. These frequencies were then aggregated and converted to percentages based on the total number of teachers at each school level (e.g., 3% for kindergarten teachers in preparation-phase material selection) to identify patterns of "fragmentation of practice" across levels.

Table 1. Research Procedure

No	Research Questions	Related Methodology Flow	Research Subject	Analytical Instruments & Techniques
1	To what extent do kindergarten teachers represent the mastery of the prerequisite knowledge of DI based on the 4:9:2 formula?	Steps 1 & 2: Initial knowledge gathering and identification of knowledge representations.	All Teachers (Early population)	Literature study, STAR Essay, and Concept Mapping of DI skills.
2	What specific cognitive barriers in the preparation phase hinder the transformation of assessment data into proactive instructional design for teachers in the field?	Steps 2 & 3: Advanced concept mapping and the beginning of the focused elicitation process.	All Teachers and Teachers Selected	Comparative analysis of concept maps and initial screening of practice fragmentation cases.
3	How do expert teachers cognitively bridge the gap between pre-assessment implementation and learning adaptation design?	Steps 3 & 4: Elizabeth-focused knowledge as well as qualitative data analysis and verification.	Selected Teachers	Analysis of video recordings, *cued-recall* interviews, and *systematic coding*.

4	What are the practical rules of cognitive that guide the formation of a final DI instructional model that is ready to be adopted in the Professional Learning Community (PLC)?	Step 5: Format the final result into a ready-to-use instructional model.	Selected Teacher / Member Teacher (Synthesis Stage)	The categorization of operational findings becomes a synthesis of the final DI model for the PLC ecosystem.

RESULTS & DISCUSSION

DI Skill Mastery 4:9:2 (RQ1)

The results of the Cognitive Task Analysis (CTA) revealed that implementing DI requires a set of skills organized into three main phases: four in the preparation phase, nine in the implementation phase, and two in the evaluation phase. Data from 31 expert kindergarten teachers showed that they have a very specific mastery profile. In the preparation phase, 100% of kindergarten teachers were able to set learning goals, but only 42% routinely conducted pre-assessments. The most striking gap is the low level of use of such data for determining learning objectives (3%) and for choosing materials (3%). In the implementation phase, kindergarten teachers showed high mastery in providing explanations (81%) and additional support (90.32%), but very low in providing time flexibility (2%). In the evaluation phase, only 32% of kindergarten teachers offered a variety of assessment options, far behind other teacher levels, which reached 69%.

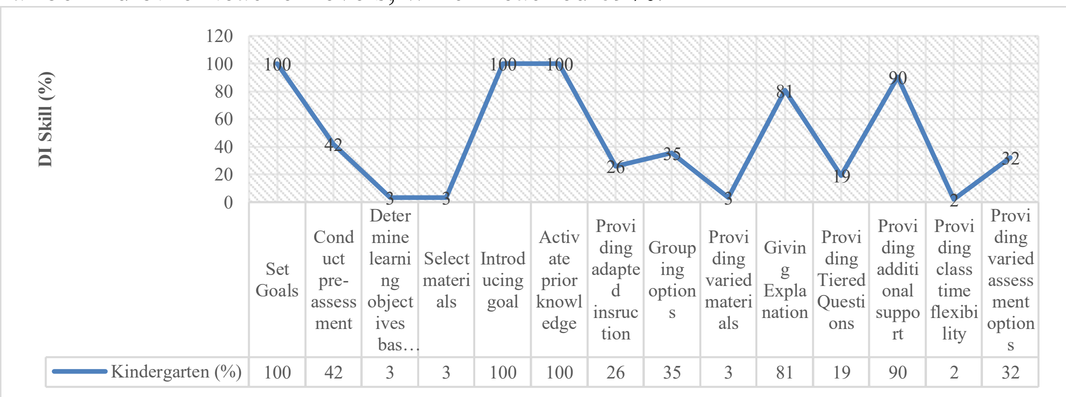

Figure 1. Percentage of DI Skill for Kindergarten Teachers

The findings of this study confirm the existence of an acute phenomenon of "practice fragmentation" at the kindergarten level, with a wide gap between pre-assessment implementation (42%) and the use of data for instructional design (3%). Theoretically, these findings strengthen the argument that DI is not just a matter of administrative technical skills but rather a high-level cognitive activity that requires a substantial mental workload (Frerejean et al., 2021; Meutstege et al., 2023).

Teacher's Cognitive Impairment (RQ2)

The cognitive barriers, in the form of an activity-driven mindset, found in this study provide a psychological explanation for the controversy over the effectiveness of DI in the global literature (Deunk et al., 2018; Roy et al., 2015). Why have some global studies found that DI is at risk of having negative effects on low-performing students? The findings of this study show that teachers often differentiate spontaneously and reactively in the classroom (90.32%) without proactive instructional design planning in the preparation phase (only 3%). Reactive differentiation tends to be trapped in assigning tasks "from busy" to keep the class orderly, rather than adapting instruction to the quality of instruction within the child's *Zone of Proximal Development* (Juwita, Sukmawati, Santosa, et al., 2025).

This study also shows that the low implementation of data-based instructional design among kindergarten teachers is not primarily due to the absence of assessment, but rather to teachers' limited ability to translate data into pedagogical actions (Maulana et al., 2020; Sun et al., 2016). The literature on data use confirms that teachers often have difficulty understanding, interpreting, and analyzing data, and then developing them into relevant instructional strategies and follow-up learning. In the context of data literacy, this problem arises when the process stops before the stage of transforming information into decisions and evaluation of results, so that the chain of instructional actions does not run in its entirety (Kim, 2024; Sun et al., 2016).

In the context of early childhood education, these barriers become more complex because assessments are not drawn from a single instrument but from teacher observations, work samples, children's background information, and various forms of developmental documentation (Pekis, 2025; Varier & Yun, 2023). Because the use of early childhood assessment differs from that in elementary and junior high schools, teachers need special skills such as intentional observation, use of multi-source data, and development-based pedagogical reasoning (Varier & Yun, 2023). Multicase evidence among preschool teachers also shows a continuum of practice, from just conducting assessments to integrated data use, and about one-third of teachers do not move beyond the data collection stage to sensemaking (Schachter & Piasta, 2021).

How to Bridge the Gap (RQ3)

The third research finding reveals why there is "practice fragmentation": namely, a sharp cognitive gap between awareness of the need to conduct assessments and the execution of instructional designs. Although 42% of kindergarten teachers conduct pre-assessments, the data rarely translates into concrete planning strategies. In comparison, secondary teachers showed a data-use rate of 78% for material selection, while kindergarten teachers were at only 3%. This shows that, for the majority of kindergarten teachers, pre-assessment results are often only administrative documents rather than the basis for designing teaching modules.

The finding that kindergarten teachers conduct pre-assessments but rarely translate them into concrete planning strategies is in line with evidence that assessment use in early childhood education is different from the context of elementary or junior high school, because it relies more on observations, work samples, and background information on children than on formal data systems (Varier & Yun, 2023). Therefore, the transition from data to instructional decisions is often fragile if teachers lack the specific skill sets for intentional observation, aggregating data from various sources, and assessment-based decision-making (Varier & Yun, 2023).

Multicase studies of preschool teachers show a continuum of data practice, from simply "doing assessment" to "integrated data use", and one-third of teachers never move beyond the data collection stage to sensemaking (Schachter & Piasta, 2021). The findings are closely aligned with the concept of "practice fragmentation," as teachers may recognize the importance of assessment yet still miss a key step: turning data into learning decisions (Schachter & Piasta, 2021). This gap persists because the barriers are layered, ranging from limitations in teachers' analytical skills and school assessment culture to limited autonomy in designing learning (Elden & Aras, 2024; Schelling & Rubenstein, 2021). That is, these findings are strongest when positioning "practice fragmentation" as the breaking of the chain of instructional actions among assessment, interpretation, and learning design (Sun et al., 2016).

This is where the *Cognitive Task Analysis* (CTA) method shows a crucial contribution of novelty. Previous research on DI in Indonesia generally relied on surveys or surface observations to examine what teachers were doing. Instead, the study succeeded in dismantling what expert teachers were thinking. *Rules of thumb* from expert teachers (such as the 80:20 rule) show that they manage cognitive overload by maintaining a structured, automated mental schema for navigating the heterogeneous complexity of the classroom (Clark et al., 2008; Frerejean et al., 2021; van Geel et al., 2019).

Best Practices and Cognitive "*Rules of Thumb*" (RQ4)

Although the percentage is low, identifying expert teachers yields practical cognitive rules that can be adopted. Expert teachers use flexible grouping strategies based on skill level and provide activities that vary according to learning styles, such as picture books for visual learners and hands-on activities for kinesthetic learners. In addition, *the choice board* strategy is used to maintain student involvement by providing autonomy in choosing activities of interest.

Expert teachers tend to use temporary groupings based on learning needs and lesson objectives, rather than fixed groups (Palieraki & Koutrouba, 2021). Evidence from classroom action shows that ability-based grouping can increase participation and engagement and reduce requests for help when combined with student-aligned activities. However, grouping like this needs to be re-evaluated periodically to avoid freezing into capability labeling (Palieraki & Koutrouba, 2021).

> *In a self-reported STAR essay (Resp_P_13), a teacher described a proactive instructional initiative beginning with a non-cognitive diagnostic assessment for 21 students to identify their unique learning profiles. The results revealed a diverse distribution of 9 visual, 9 kinesthetic, and 3 auditory learners. Leveraging this data, the teacher implemented flexible grouping by organizing the class into nine distinct groups based on their learning styles and designed learning processes that utilized diverse school environments, such as a literacy gazebo, a classroom garden, a fishpond, and a library. This approach facilitated product differentiation, allowing students to demonstrate their mastery in varied formats—including worksheets, audiovisual recordings, Canva posters, and creative "Plant Magic Books"—which they completed either individually or in groups.*

Grouping becomes effective when it is based on the teacher's observations, even if it seems random to students. Although for students, the grouping makes them less comfortable because they are not with their close friends, cognitively, teachers are conducting continuous monitoring, identified by the CTA as a core skill in the implementation phase, to ensure each child is within their Zone of Proximal Development (ZPD) (Palieraki & Koutrouba, 2021). This reliance on observation explains why kindergarten teachers are more dominant in reactive differentiation than in proactive design planned on paper.

The kindergarten teacher makes pedagogical decisions based on his knowledge of the child's development and changes those decisions as the child's needs change. The low rate of adoption of proactive instruction (only 26%) among kindergarten teachers is likely driven by the belief that children's needs change rapidly in early childhood. Kindergarten teachers tend to adjust their plans midway when children's needs shift, rather than fixating on rigid teaching modules. The focus on play-based and exploratory learning makes them prioritize responsiveness to the child's actual development over formal data-driven structures (Sullivan et al., 2023)

Classroom data that is specific to children and classes helps with planning and in-the-moment instruction. However, this study shows fragmentation in practice. The assessment data collected by kindergarten teachers is often only used as background information to conduct "in-the-moment instruction", but fails to be transformed into proactive instructional design before lessons begin (Schachter & Piasta, 2021)

> *In a self-reported STAR essay (Resp_K_01), a kindergarten teacher noted a lack of diverse social interactions among students who initially preferred socializing only with immediate peers. To address this, the teacher proactively designed a play-based instructional intervention by integrating a hide-and-seek game with tasks differentiated according to learning profiles. Auditory learners were tasked with arranging words using loose parts; visual learners engaged in coloring activities; and kinesthetic learners participated in an active game. The teacher also utilized "hompimpah," a local decision-making game, to ensure equitable role selection and foster student agency. This approach led to a more socially inclusive environment, effectively breaking down selective social barriers among students.*

The second good practice is to provide a variety of activities that suit children's needs, interests, and learning styles, and then offer children space to choose, so they stay engaged. Kindergarten teachers are pedagogically knowledgeable about each child, enabling them to find a suitable solution and decide on the next step with the child (Sullivan et al., 2023). The evidence supports the general principle that personalization is more effective when tasks feel meaningful, offer autonomy, and are appropriate to the child's abilities (Ghaith & Awada, 2022; Palieraki & Koutrouba, 2021). Qismullah Yusuf & Reza (2026) chose learning media such as *e-comics* that allow teachers to analyze student performance patterns to adapt learning content adaptively

These findings confirm that kindergarten expert teachers use simple practical rules, namely: group flexibly, provide different activity paths, and provide targeted choices. Evidence also shows that these good practices are effective only when supported by sharp observation, regular re-evaluation, and adequate professional support.

Expert teachers demonstrate that the success of DI does not depend on random techniques but on a deep theoretical understanding, so that its implementation does not merely follow intuition. Therefore, future professional development (PD) must shift from "how to do assessments" to proactive "data translation" skills in teaching module design. Strengthening Professional Learning Communities (PLCs) is urgent to help teachers share cognitive strategies and reduce the heavy burden of preparation.

CONCLUSION

Based on the results of a cognitive analysis of the practice of kindergarten teachers in Indonesia, this study concludes several main things, namely the identification of a sharp phenomenon of "practice fragmentation", where there is a gap between administrative awareness and pedagogical execution. Although as many as 42% of kindergarten teachers routinely conduct pre-assessments, only 3% are cognitively able to bridge the data to design learning objectives and choose materials. This shows that assessment data often serves only as a formal document without being transformed into concrete instructional design.

The main barrier to proactive instructional design is the dominance of reactive differentiation (90.32%) over proactive differentiation (26%). Kindergarten teachers tend to get caught up in the mental model that DI is just a physical grouping of students, rather than an adaptation of planned, in-depth instruction. In addition, an excessive focus on play-based learning often leads teachers to avoid data-driven planning structures they consider too rigid.

Expert teachers in Indonesia show very strong mastery in the implementation phase (especially in providing additional support), but very weak in the preparation phase. The 4:9:2 skill structure reveals that the critical point of failure in DI implementation does not lie in the teacher's will but rather in a lack of "data translation" skills prior to entering the classroom. Expert teachers who successfully overcome cognitive barriers use several key strategies, such as flexible grouping based on play observations and choice boards to give students autonomy.

This study has several main limitations, namely the reliance on self-report data from STAR essays, which risks introducing ideal-report bias, in which teachers may provide answers that are considered socially desirable. The sample size of 31 expert teachers also limits the generalizability of the research results to the entire teacher population across various educational contexts in Indonesia. In addition, this analysis has not fully integrated direct classroom observations with student learning achievement data to prove the real effectiveness of the reported strategies. Finally, the study has not taken into account, in depth, external variables such as the teacher-student ratio or specific levels of administrative support, which can affect teachers' cognitive space when designing instructional designs.

As a recommendation, teachers' professional development programs should be immediately reoriented from simply teaching how to collect assessment data to intensive training in the cognitive skills of "data translation," integrated into proactive teaching modules. Schools are advised to strengthen Learning Communities to facilitate regular discussions among teachers and to share cognitive "practical principles" for collaboratively coping with heavy planning workloads. At the policy level, the government needs to support efforts to reduce the student-teacher ratio and provide adaptive learning media and supporting technology to make it easier for teachers to differentiate instruction. Researchers are further advised to conduct longitudinal studies that integrate authentic observation methods to holistically measure the long-term impact of implementing data-driven instructional design on student engagement and achievement.

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