

From Adaptive Teaching Theory to Classroom Practice: A Design-Based Research Protocol for Diverse Learners

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Abstract

The theory–practice gap remains a persistent problem in education because research often produces abstract principles, whereas classroom teaching requires situated judgment under conditions of learner diversity, curricular constraint, and uncertainty. This paper presents a design-based research (DBR) protocol for developing and refining an Adaptive Teaching Framework (ATF) intended to translate established principles of adaptive teaching into an observable and revisable classroom decision architecture. The framework integrates research on adaptive teaching, differentiated instruction, inclusive pedagogy, formative assessment, scaffolding, and teacher professional judgment. Rather than introducing new mechanisms of adaptation, the ATF organizes established principles into six interdependent decision functions: planning for learner diversity; interpreting learner needs; selecting an adaptive response; enacting and calibrating support; evaluating learner response through formative evidence; and reflecting and recalibrating instruction. The framework is explicitly recursive, with both in-lesson and between-lesson feedback loops, and is constrained by an inclusive-pedagogy principle requiring adaptation to preserve participation in shared curricular purposes. A two-cycle DBR protocol is proposed in authentic school settings, combining teacher co-design, classroom implementation, observation, interviews, teaching artifacts, formative evidence, and documented framework revision. The study asks how teachers interpret and enact the framework, which design features support or constrain its use, how contextual conditions shape adaptation, how the framework changes across iterative cycles, and what evidence of student participation and learning should inform revision. Because fieldwork has not yet been conducted, no findings are reported. The intended contribution is to provide an empirically revisable account of how adaptive-teaching principles are translated into classroom decision processes and how classroom evidence, in turn, modifies the framework and its underlying design principles.

Keywords: adaptive teaching; differentiated instruction; inclusive pedagogy; design-based research; professional judgment; formative assessment; scaffolding; theory–practice gap.

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1. Introduction

Classrooms are characterized by substantial variation in students' prior knowledge, language proficiency, motivation, learning pace, socio-economic background, and support needs. Teachers are expected to respond to this diversity while maintaining coherent curricular goals and meaningful participation for all learners (Deunk et al., 2018; Smale-Jacobse et al., 2019).

Educational research offers several bodies of knowledge relevant to this challenge, including adaptive teaching (Corno, 2008), differentiated instruction (Tomlinson, 2001), inclusive pedagogy (Florian & Black-Hawkins, 2011), formative assessment (Black & Wiliam, 1998), and instructional scaffolding (van de Pol et al., 2010). Yet translating these principles into classroom decisions remains difficult, particularly when teachers must diagnose emerging needs and adjust instruction in real time (Bondie et al., 2019; Gaitas & Alves Martins, 2017; Parsons et al., 2018).

The resulting theory–practice gap should not be understood simply as a failure of teachers to apply research. It arises from the interaction of abstract knowledge, situated professional judgment, institutional constraints, and the limitations of educational principles when they are transferred into complex classroom settings (Korthagen & Kessels, 1999; Schön, 1983; Zeichner, 2010). Teaching requires more than knowledge of general principles: it requires teachers to notice relevant events, interpret incomplete evidence, select among competing responses, and adjust those responses as classroom conditions change (Goodwin, 1994; Shulman, 1987; van Es & Sherin, 2008).

This paper addresses that problem through design-based research (DBR), a methodology developed to study and improve educational designs through iterative cycles in authentic settings while generating both practical and theoretical knowledge (Brown, 1992; Cobb et al., 2003; Collins et al., 2004; Design-Based Research Collective, 2003; McKenney & Reeves, 2018). The study develops and iteratively refines an Adaptive Teaching Framework (ATF) in collaboration with practicing teachers.

The contribution of the ATF does not lie in proposing entirely new principles of adaptive teaching. Rather, it integrates established mechanisms proactive planning, professional noticing, formative evidence, contingent scaffolding, fading, transfer of responsibility, and inclusive participation into an observable decision architecture that can be enacted, studied, and revised. Through two DBR cycles, the study will examine how teachers interpret and transform this architecture in practice and how classroom evidence requires the initial framework to be retained, reorganized, simplified, or extended. Because fieldwork has not yet been conducted, the manuscript is presented as a DBR protocol. No empirical outcomes are reported. The purpose is to specify the theoretical architecture, research questions, iterative methodology, evidence requirements, and revision logic before claims about implementation or educational meaningfulness are made.

2. Adaptive Teaching and the Theory–Practice Problem

The theory–practice problem in adaptive teaching can be understood through three connected challenges: translating abstract educational principles into situated action, exercising professional judgment under uncertainty, and designing practical structures that make adaptive reasoning visible and usable.

Research knowledge is typically formulated at a level of abstraction that allows principles to travel across settings, whereas teaching requires decisions about particular learners in particular moments. Korthagen and Kessels (1999) and Schön (1983) emphasize that professional practice cannot be reduced to the mechanical application of formal knowledge. Teachers must interpret classroom events through professional vision (Goodwin, 1994; van Es & Sherin,

2008), draw on specialized professional knowledge (Shulman, 1987), and respond adaptively when established routines do not fit emerging situations (Bohle Carbonell et al., 2014). The problem is therefore not simply how to transfer theory into practice, but how to create usable decision structures that help teachers connect principles to evidence, judgment, and action without replacing professional discretion. Practice-based approaches to teacher education similarly argue that professional knowledge becomes meaningful when it is organized around the work of teaching rather than presented separately from practice (Ball & Forzani, 2009; Grossman et al., 2009).

DBR is particularly appropriate for this problem because it treats educational design itself as a site of inquiry. Instead of asking only whether a fixed intervention works, DBR examines how an initial design interacts with authentic settings, why particular elements succeed or fail, and how iterative modification contributes to both a more usable design and a more refined theoretical account (Brown, 1992; Cobb et al., 2003; McKenney & Reeves, 2018).

2.1 Adaptive Teaching, Differentiation, and Inclusion

Adaptive teaching refers broadly to the deliberate adjustment of instruction in response to variation in learner needs. Corno (2008) characterizes adaptation as both proactive, through anticipation of learner diversity during planning, and responsive, through adjustment to evidence emerging during instruction. Empirical syntheses indicate that teachers do adapt instruction, but such adaptations vary considerably in frequency, depth, and instructional purpose and are shaped by curricular, temporal, assessment, and organizational constraints (Parsons et al., 2018).

Differentiated instruction represents one important strategy within this broader adaptive process. It emphasizes proactive modification of content, process, product, and learning conditions according to student readiness, interests, and learning profiles (Tomlinson, 2001; Tomlinson et al., 2003). Evidence suggests potential benefits, although effects depend substantially on implementation quality and the research base remains uneven across educational levels (Deunk et al., 2018; Smale-Jacobse et al., 2019).

Individualization and personalization represent related but conceptually distinct forms of instructional adaptation. Individualization generally refers to adjusting pacing or sequencing to individual learners, whereas personalization more explicitly incorporates learner choice or influence over goals, content, or pathways. The ATF treats these approaches as possible design strategies within adaptive teaching rather than as competing instructional paradigms.

Inclusive pedagogy provides the normative constraint on these adaptations. Florian and Black-Hawkins (2011) argue that responding to diversity should not require separating learners into fixed categories or creating fundamentally different educational opportunities for selected groups. Adaptation should instead extend what is ordinarily available while sustaining participation in shared learning. Consequently, the ATF treats inclusion not as an additional technique but as a principle that constrains every adaptive decision: instructional variation should respond to need without unnecessarily fragmenting the learning community or lowering access to common curricular purposes.

2.2 Formative Evidence, Scaffolding, and Professional Judgment

Adaptive teaching depends on a continuous relationship among evidence, interpretation, instructional response, and evaluation. Formative assessment provides the evidence mechanism for this relationship. Teachers elicit information about learning, interpret its significance, and use that interpretation to decide what should happen next (Black & Wiliam, 1998, 2009).

Scaffolding research specifies an important mechanism for translating such evidence into adaptive support. Effective scaffolding is characterized by contingency, meaning that assistance is matched to learners' current understanding; fading, meaning that support is reduced as competence develops; and transfer of responsibility, meaning that control of the learning process progressively shifts toward the learner (van de Pol et al., 2010, 2015; Wood et al., 1976). These mechanisms make clear that adaptation cannot be reduced to providing more support to students who appear to struggle. The instructional response must be calibrated to evidence and subsequently adjusted according to learner response. The interpretive work connecting evidence and instructional response depends on professional judgment. Teachers must determine which evidence is relevant, what it indicates, whether a mismatch exists between current support and learner need, and which response is educationally appropriate. This work draws on professional vision (Goodwin, 1994; van Es & Sherin, 2008), professional knowledge (Shulman, 1987), pedagogical tact (van Manen, 1991), and adaptive expertise (Bohle Carbonell et al., 2014). Accordingly, the ATF does not treat diagnosis or adaptation as automatic phases in a checklist. Its purpose is to organize professional judgment around recurrent decision functions while preserving teachers' responsibility for interpretation.

2.3 Design-Based Research as a Theory–Practice Methodology

DBR provides the methodological foundation for developing the ATF because intervention design and theory refinement proceed together. Research is conducted in authentic educational settings; teachers and researchers participate in iterative analysis and design; evidence from implementation informs revision; and the outputs include both local design artifacts and more general design principles (Brown, 1992; Cobb et al., 2003; Collins et al., 2004; Design-Based Research Collective, 2003; McKenney & Reeves, 2018).

This methodology is particularly appropriate when the object of study cannot be separated easily from its implementation context. The usability of an adaptive-teaching framework depends on time, curriculum, classroom routines, teacher expertise, learner diversity, and organizational conditions. These influences are not merely sources of experimental noise; they constitute part of the phenomenon being studied.

The present study therefore uses two iterative cycles not primarily to estimate an intervention effect but to investigate how an adaptive-teaching decision architecture is interpreted, enacted, constrained, and revised. The methodological emphasis is on transparent documentation of the relationship between evidence and design change so that the development of the framework remains auditable rather than being presented as an unexplained sequence of improvements.

3. Theoretical Foundations and Conceptual Boundaries

The ATF integrates four complementary theoretical commitments, first, sociocultural learning and scaffolding theory provide the mechanism of calibrated instructional support. Learning is

supported when assistance responds to learners' emerging competence and is progressively withdrawn as responsibility shifts toward the learner (Vygotsky, 1978; Wood et al., 1976; van de Pol et al., 2010, 2015).

Second, formative-assessment theory provides the evidence cycle. Adaptive instruction requires the elicitation and interpretation of evidence that informs subsequent teaching and learning decisions (Black & Wiliam, 1998, 2009). Formative evidence is therefore not a separate assessment activity appended to teaching; it is part of the adaptive process itself.

Third, professional-judgment theory explains how evidence becomes action. Teachers do not simply apply predetermined rules to diagnostic information. They notice, interpret, prioritize, and respond through situated judgment informed by professional knowledge and adaptive expertise (Goodwin, 1994; Shulman, 1987; van Es & Sherin, 2008; van Manen, 1991; Bohle Carbonell et al., 2014).

Fourth, inclusive pedagogy establishes the normative condition under which adaptation is considered educationally legitimate. Adaptation should increase access and participation within shared curricular purposes rather than reinforce fixed assumptions about ability or create unnecessary separation among learners (Florian & Black-Hawkins, 2011; Florian & Spratt, 2013).

Drawing these traditions together, the study defines adaptive teaching as:

the deliberate, evidence-informed calibration of instruction both planned and responsive to emerging learner needs within a shared classroom community, enacted through contingent support and professional judgment while preserving access to common curricular purposes.

This definition positions adaptive teaching as the overarching process. Differentiated instruction, individualization, and personalization are possible strategies within that process, while inclusive pedagogy constrains how adaptation should be designed and interpreted.

Table 1. Conceptual distinctions among adaptive teaching and related constructs

Concept	Core meaning	Analytical status	Relationship to ATF
Adaptive teaching	Planned and responsive calibration of instruction to emerging learner needs	Overarching instructional process	Core construct of the framework
Differentiated instruction	Proactive variation in content, process, product, or learning conditions in response to learner differences	Design strategy	One possible proactive adaptive strategy
Individualization	Adjustment of pace, sequence, or support to individual learners	Implementation strategy	Optional form of adaptation
Personalization	Adaptation incorporating meaningful learner influence over goals, content, pace, or pathways	Implementation strategy	Optional agency-oriented form of adaptation
Inclusive pedagogy	Extending participation in shared learning while avoiding unnecessary categorization and separation	Normative orientation	Constrains all ATF decisions

These distinctions are analytically important because the ATF does not assume that every form of differentiation or individualization is necessarily adaptive or inclusive. A modification qualifies as adaptive only when it responds to evidence of learner need, is educationally

purposeful, and is evaluated in relation to the learner's subsequent response. Similarly, adaptation is considered inclusive only when variation does not unnecessarily restrict participation in shared learning.

4. Research Gap and Contribution

Research has established important elements of adaptive teaching, but these elements remain distributed across partially separate literatures. Adaptive-teaching research emphasizes proactive and responsive adjustment (Corno, 2008; Parsons et al., 2018); differentiated-instruction research focuses on planned variation (Tomlinson, 2001; Deunk et al., 2018); scaffolding research specifies contingency, fading, and transfer of responsibility (van de Pol et al., 2010, 2015); formative-assessment research explains evidence-informed adjustment (Black & Wiliam, 1998, 2009); and inclusive pedagogy emphasizes participation within shared learning (Florian & Black-Hawkins, 2011).

The gap is therefore not an absence of adaptive-teaching principles. Rather, it is an integration and enactment problem. Existing research provides strong accounts of individual mechanisms but offers less guidance about how these mechanisms can be organized into a coherent decision architecture that connects planning, real-time interpretation, instructional response, evaluation of learner response, and subsequent recalibration.

A second gap concerns empirical revisability. Frameworks for teaching are often presented as finished representations of good practice rather than provisional designs whose assumptions can be modified through evidence of classroom enactment. This is particularly problematic for adaptive teaching because the construct itself concerns responsiveness to context. A framework that cannot change when confronted with evidence of implementation difficulty would contradict its own theoretical commitments.

The contribution of the proposed study is therefore threefold. First, it integrates established adaptive-teaching mechanisms into an explicit decision architecture. Second, it uses DBR to examine how that architecture is transformed through teacher enactment and contextual constraint. Third, it documents the evidence underlying every major revision so that the relationship among theory, design, implementation, and refinement remains transparent.

The study does not claim that no previous framework for adaptive instruction exists. Its more specific contribution is to test whether integrating proactive planning, professional noticing, contingent scaffolding, formative evaluation, professional judgment, and inclusive participation within a recursive framework provides a useful basis for studying and supporting adaptive classroom decision-making.

5. Initial Adaptive Teaching Framework (ATF)

The initial ATF consists of six interdependent decision functions within a recursive adaptive cycle, rather than six rigidly sequential instructional stages. The framework begins with proactive planning for diversity, but adaptation does not proceed through a simple linear progression. Interpretation, instructional response, formative evidence, and recalibration can occur repeatedly within a single lesson and across successive lessons. The framework therefore includes two timescales of adaptation: an in-lesson loop, in which teachers respond to emerging evidence during instruction, and a between-lesson loop, in which accumulated evidence informs subsequent planning.

Six decision functions organize the initial framework.

1. Plan for diversity.

Teachers anticipate likely variation in prior knowledge, participation, language, pace, and support requirements while preserving shared curricular goals. Potential variations are prepared in advance without assuming that all predicted differences will require intervention (Corno, 2008; Tomlinson, 2001).

2. Interpret learner need.

Teachers notice and interpret evidence indicating a possible mismatch between current instructional conditions and learner understanding or participation. Evidence may arise from questioning, observation, student work, formative tasks, or interaction during instruction (Goodwin, 1994; van Es & Sherin, 2008).

3. Select an adaptive response.

Teachers determine whether adaptation is needed and select an instructional response proportionate to the interpreted need. Selection involves professional judgment rather than automatic matching of learner categories to predetermined interventions.

4. Enact and calibrate support.

Teachers implement the selected response through strategies such as prompting, modeling, feedback, regrouping, representation, task adjustment, or peer support. Support is calibrated according to learner response and reduced or altered when greater independence becomes possible (Wood et al., 1976; van de Pol et al., 2010, 2015).

5. Evaluate learner response.

Teachers collect and interpret formative evidence specifically to determine whether the adaptive response produced the intended learning or participation change. This function distinguishes evidence used to identify a need from evidence used to evaluate the effectiveness of the response (Black & Wiliam, 1998, 2009).

6. Reflect and recalibrate.

Teachers determine whether the current response should be maintained, intensified, reduced, changed, or discontinued. Recalibration may occur immediately within the lesson or inform subsequent lesson planning (Schön, 1983; Bohle Carbonell et al., 2014).

Inclusive pedagogy operates across all six functions rather than as an external add-on. Planning should preserve meaningful shared goals; interpretation should avoid deterministic labeling; adaptive responses should minimize unnecessary separation; implementation should support participation; formative evidence should examine both learning and access; and reflection should consider whether adaptations have unintentionally restricted belonging or curricular opportunity (Florian & Black-Hawkins, 2011).

Table 2. Initial Adaptive Teaching Framework: decision functions and theoretical mechanisms

Decision function	Core question	Principal process	Key theoretical anchors
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1. Plan for diversity	What learner variation can reasonably be anticipated while maintaining shared purposes?	Proactive preparation of flexible pathways and supports	Corno (2008); Tomlinson (2001)
2. Interpret learner need	What does current evidence suggest about mismatch between instruction and learner need?	Professional noticing and interpretation	Goodwin (1994); Shulman (1987); van Es & Sherin (2008)
3. Select adaptive response	What response is educationally appropriate and proportionate to the interpreted need?	Situated professional judgment	Shulman (1987); van Manen (1991); Bohle Carbonell et al. (2014)
4. Enact and calibrate support	How should support be provided and adjusted as the learner responds?	Contingency, scaffolding, fading, transfer of responsibility	Wood et al. (1976); van de Pol et al. (2010, 2015)
5. Evaluate learner response	Did the adaptation improve understanding, participation, or independence?	Formative evidence after or during adaptive action	Black & Wiliam (1998, 2009); Hattie & Timperley (2007)
6. Reflect and recalibrate	Should the instructional response be sustained, modified, faded, or replaced?	Reflection-in-action and reflection-on-action	Schön (1983); Bohle Carbonell et al. (2014)

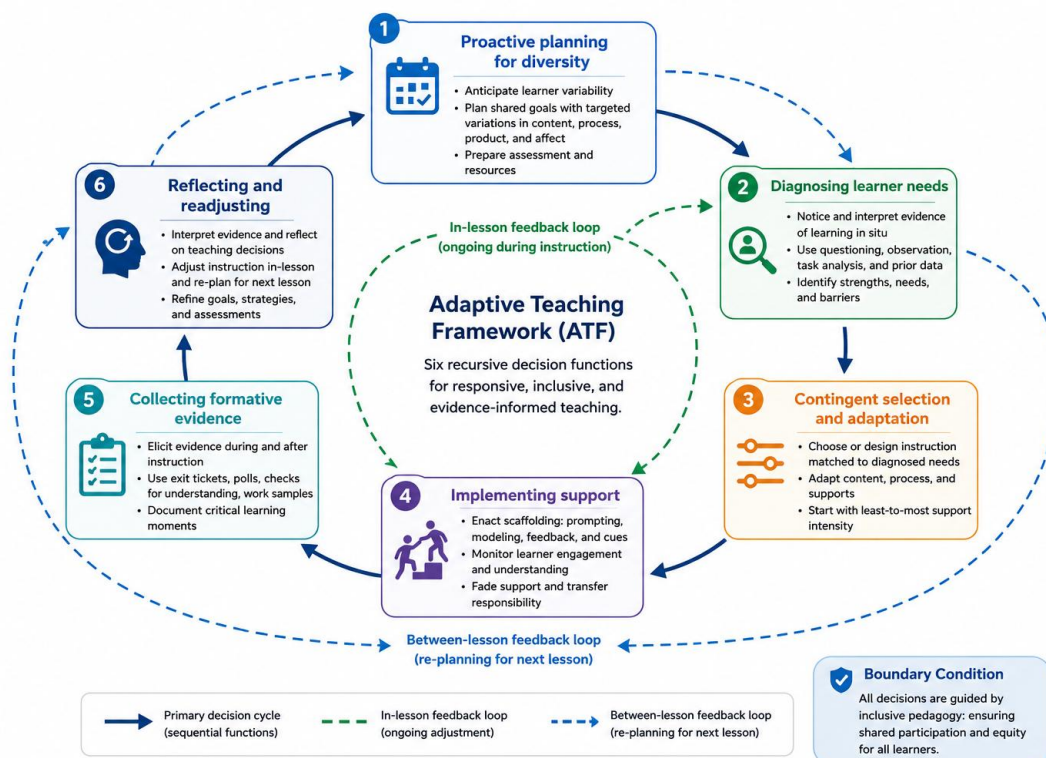


Figure 1. Initial Adaptive Teaching Framework (ATF): six recursive decision functions with in-lesson and between-lesson feedback loops.

The ATF should therefore be understood as a decision architecture for adaptive professional judgment, not as a procedural checklist. Its validity will depend on whether teachers can use, modify, and potentially simplify this architecture in authentic classroom settings without losing its core mechanisms of contingency, formative responsiveness, professional judgment, and inclusive participation.

6. Research Questions

The study examines not only whether teachers use the Adaptive Teaching Framework (ATF), but how its theoretical assumptions are interpreted, negotiated, and transformed through classroom practice. Five research questions guide the two DBR cycles:

RQ1. Enactment: How do teachers interpret and enact the decision functions of the ATF in heterogeneous classrooms, and how does enactment vary within and across teachers and contexts?

RQ2. Design usability: Which features of the ATF and its associated tools support teachers' adaptive decision-making, and which features generate implementation difficulties or require modification?

RQ3. Context: What classroom, curricular, organizational, and professional conditions enable or constrain teachers' adaptive decision-making?

RQ4. Framework evolution: How and why does the ATF change across iterative DBR cycles, and what do these revisions reveal about the relationship between the initial theoretical model and adaptive teaching as enacted in practice?

RQ5. Educational meaningfulness: What evidence suggests that enacted adaptations support students' participation, learning progress, and increasing independence rather than simply increasing the observable frequency of instructional variation?

Together, these questions distinguish enactment, usability, context, theoretical revision, and educational meaningfulness. This distinction is important because frequent adaptation cannot itself be assumed to constitute effective adaptive teaching. An adaptation may be observable yet poorly matched to learner need, unnecessarily intrusive, or inconsistent with inclusive participation. Consequently, the study examines not only whether adaptation occurs but also its contingency, consequences, and relationship to the framework's theoretical mechanisms.

7. Methodology

7.1 Research Design and DBR Cycles

The study adopts a design-based research methodology in which educational design and theoretical development proceed iteratively in authentic settings (Brown, 1992; Cobb et al., 2003; Collins et al., 2004; Design-Based Research Collective, 2003; McKenney & Reeves, 2018). DBR is appropriate because the ATF is not treated as a fixed intervention whose effectiveness can be evaluated independently of implementation. Rather, the study investigates how the framework interacts with teachers' professional judgment, existing classroom routines, learner diversity, and institutional conditions, and how evidence from those interactions should modify the framework itself.

The study is planned over approximately 18 months and comprises two major DBR cycles. Each cycle includes six analytically distinguishable but practically overlapping activities:

1. **Problem analysis:** examining existing adaptive practices, learner diversity, teacher needs, and contextual constraints;
2. **Co-design:** adapting the ATF and associated tools collaboratively with participating teachers;

3. **Implementation:** enacting the framework in authentic classroom practice;
4. **Evidence generation:** collecting multiple forms of evidence concerning enactment, usability, context, and learner response;
5. **Evaluation and interpretation:** examining evidence against the research questions and the theoretical assumptions of the framework; and
6. **Revision:** modifying the ATF, its tools, or its underlying propositions before subsequent implementation.

These activities should not be interpreted as a strictly linear sequence. Consistent with DBR methodology, smaller cycles of implementation, reflection, and modification may occur within each major cycle when usability problems or contextual mismatches become apparent. Major conceptual changes to the ATF, however, will be documented formally at the end of each cycle to preserve an auditable account of framework evolution.

Teacher co-design is central to this process. Participating teachers are treated as professional partners whose situated knowledge contributes to design decisions rather than as implementers expected to reproduce a researcher-designed model unchanged. At the same time, co-design does not mean that every local preference automatically becomes part of the framework. Proposed modifications will be examined against classroom evidence and the ATF's theoretical commitments to contingency, formative responsiveness, learner independence, professional judgment, and inclusive participation.

Cycle 1: Initial Enactment and Design Diagnosis

Cycle 1 will examine the enactability of the initial ATF developed from the literature. It will begin with baseline documentation of existing adaptive practices through classroom observations, teacher interviews, and analysis of relevant teaching materials. These data will establish how participating teachers currently anticipate learner diversity, interpret learner needs, adjust instruction, use formative evidence, and reflect on adaptive decisions before formal introduction of the ATF.

The initial framework will then be introduced through co-design workshops. Rather than prescribing a standardized package, researchers and teachers will develop contextually appropriate representations of the framework, potentially including planning prompts, noticing guides, formative-evidence routines, scaffolding decision supports, and reflection formats. The precise tools will be documented as local instantiations of the framework rather than treated as universal components of the ATF.

Teachers will implement the framework during one school term, accompanied by biweekly co-design and reflection meetings. Evidence of implementation difficulty may lead to minor usability modifications during the cycle. Such modifications will be documented rather than treated as methodological deviations, because adaptation of the design in response to implementation evidence is itself part of the DBR process.

At the end of Cycle 1, researchers and teachers will conduct a structured evaluation examining which components were enacted, how they were transformed, where friction occurred, and whether observed adaptive responses were consistent with the framework's theoretical mechanisms. This analysis will inform the design of Cycle 2.

Cycle 2: Revised Enactment and Theoretical Refinement

Cycle 2 will implement the revised ATF generated from Cycle 1 evidence. The second cycle will retain sufficient continuity in observation, interview, artifact, and learner-evidence procedures to permit systematic comparison across cycles while allowing design modifications justified by Cycle 1 findings.

Importantly, Cycle 2 modifications will not be predetermined. Features such as peer observation, additional student feedback, revised planning tools, or alternative reflection routines may be introduced if Cycle 1 evidence indicates that they address documented problems or strengthen theoretically important mechanisms. This evidence-contingent approach prevents the second cycle from functioning merely as implementation of changes anticipated in advance.

Cycle 2 will therefore test two related questions: whether modifications improve the framework's usability and enactability, and whether the resulting changes require refinement of the theoretical account of adaptive teaching itself.

7.2 Context and Participants

The study will be conducted in two schools selected purposively to provide contrasting but analytically relevant contexts. One primary and one secondary school within the same educational jurisdiction will be recruited. Selection criteria will include: (a) substantial learner diversity; (b) institutional willingness to participate in sustained collaborative inquiry; and (c) sufficient organizational support for teacher participation across both DBR cycles.

Including two educational levels is intended to examine the transferability of the framework's underlying design logic, not to provide a statistically representative comparison between primary and secondary education.

Approximately four teachers will be recruited from each school, producing an anticipated sample of eight participating teachers. Purposive variation will be sought in teaching experience, subject area, and prior familiarity with adaptive or differentiated instruction. Participation will be voluntary.

The classrooms of participating teachers will constitute the learner contexts for the study, with an anticipated total of approximately 150–220 students. Students are not conceptualized simply as outcome units; their classroom participation, work, formative-assessment evidence, and where ethically approved and methodologically appropriate perspectives on instructional responsiveness will provide evidence concerning the consequences of teachers' adaptive decisions.

Particular analytical attention will be paid to whether adaptive practices expand or restrict opportunities for students whose learning needs may not be adequately served by uniform instruction. However, student categories will not be treated as fixed explanatory labels. This approach is consistent with the inclusive-pedagogy commitment to avoiding deterministic assumptions about ability (Florian & Black-Hawkins, 2011).

7.3 Data Sources and Data Collection

A multi-source evidence strategy will be used because no single data source can adequately capture adaptive teaching as a process of noticing, interpretation, action, learner response, and professional reflection.

Classroom observations

Classroom observations will provide the primary evidence of enacted adaptive practice. Approximately four focal lessons per teacher per DBR cycle will be video recorded, supplemented by baseline observations before formal implementation.

The observation framework will be aligned with the six ATF decision functions while remaining open to adaptive practices not anticipated by the initial model. Coding will identify episodes involving: anticipation of learner variation; evidence of learner need; teacher interpretation or response to such evidence where observable; selection and modification of instructional support; scaffolding moves; formative elicitation; fading or continuation of support; and subsequent learner response.

Particular attention will be given to contingency, defined as the degree of correspondence between observed learner need and subsequent instructional support (van de Pol et al., 2010, 2015). This emphasis shifts analysis from counting adaptations to examining their responsiveness.

A structured coding manual will be developed and piloted. Two trained coders will independently code an appropriate subset of observations, and inter-rater reliability will be reported for structured observational categories.

Teacher interviews

Semi-structured interviews will be conducted before implementation and at key points during and after each cycle. Interviews will investigate teachers' interpretations of adaptive teaching, rationales for instructional decisions, experiences with ATF tools, perceived contextual constraints, and reflections on framework modifications.

Interviews are particularly important for examining aspects of professional judgment that cannot reliably be inferred from observation alone. Observed instructional actions will therefore not automatically be interpreted as evidence of particular teacher intentions.

Co-design records

Co-design meetings will be audio recorded, transcribed or systematically summarized, and documented through design records. Analysis will focus on proposals, disagreements, rejected ideas, implementation concerns, and the rationales underlying modifications.

These records are central to RQ2 and RQ4 because they make visible the processes through which theoretical constructs are translated into locally usable tools and subsequently revised.

Teaching and design artifacts

Relevant artifacts will include lesson plans, instructional materials, teacher-created adaptations, formative-assessment materials, planning tools, reflection records, and versions of ATF-related design resources.

Artifacts will be analyzed not merely as evidence that tools were used but as traces of how teachers interpreted and transformed the framework.

Learner-response evidence

Student evidence will include naturally occurring or framework-related formative assessments, work samples, exit tickets, and feasible indicators of classroom participation. These data will be used primarily to examine whether particular adaptive episodes are followed by evidence of improved understanding, participation, or independence.

Student data will be interpreted descriptively and in relation to specific classroom cases. They will **not** be used to estimate causal treatment effects.

Where Cycle 1 evidence indicates that students' perspectives are necessary to evaluate responsiveness or inclusion, a brief student-voice component may be incorporated into Cycle 2 following appropriate ethical approval.

7.4 Data Analysis

Analysis will combine structured analysis of classroom enactment with qualitative analysis of teachers' interpretations, contextual conditions, co-design processes, and framework evolution.

Structured analysis of enactment

Observation data will be analyzed using the ATF-informed coding framework. Descriptive summaries will examine the occurrence and characteristics of adaptive episodes, including evidence source, type of instructional response, degree of contingency, subsequent calibration, and learner response.

The analytical emphasis will be on patterns and trajectories rather than simple frequency. For example, an increase in instructional modifications will not be interpreted as improvement unless evidence suggests that modifications became more contingent, less unnecessarily intrusive, or more effective in supporting participation and independence.

Descriptive comparisons will be made within teachers across cycles and, cautiously, across teachers and school contexts. Inferential claims will not be made from the small purposive sample.

Qualitative analysis

Interview transcripts, co-design records, open observation notes, artifacts, and researcher reflexive records will be analyzed thematically. Initial coding will be sensitized by the research questions and theoretical constructs while remaining open to patterns that challenge or extend the ATF.

The qualitative analysis will examine, among other issues, teachers' working theories of adaptation, interpretations of learner evidence, usability tensions, contextual constraints, professional-judgment processes, and rationales for framework revision.

Because interpretive thematic analysis and structured reliability coding serve different epistemic purposes, inter-rater reliability will be applied to the structured observation scheme, not treated as a validity requirement for reflexive thematic interpretation. Qualitative credibility

will instead be strengthened through transparent analytic documentation, discussion of alternative interpretations, negative-case analysis, and triangulation across evidence sources.

7.5 Framework Revision and Cross-Cycle Analysis

Framework revision is treated as an analytical outcome rather than an implementation afterthought. A design-revision audit trail will document each consequential modification across the study.

For each proposed revision, the record will identify:

- the component or assumption under review;
- the evidence that generated concern or supported retention;
- whether evidence converged or diverged across sources;
- the theoretical principle implicated;
- the design decision taken;
- the rationale for that decision; and
- the expected consequence to be examined in the subsequent cycle.

Four broad revision outcomes are possible: retain, modify, remove, or add. These categories are descriptive rather than mechanical decision rules. For example, low observed use will not automatically justify removing an element; non-use may indicate poor usability, inadequate professional learning, contextual incompatibility, or a mistaken theoretical assumption. Distinguishing among these explanations is itself part of the analysis. Cross-cycle analysis will then examine three forms of change:

Enactment change: How did teachers' adaptive decision-making differ between cycles?

Design change: Which components or tools changed, and what evidence generated those changes?

Theoretical change: Did classroom evidence require modification of the conceptual relationships assumed by the initial ATF?

Triangulation matrices will map each research question against relevant evidence sources and document convergence, complementarity, and contradiction. Divergent evidence will be analyzed explicitly rather than forced into consensus.

The principal output of this analysis will therefore not simply be a “final” framework, but an empirically revised ATF accompanied by an evidence trace explaining why it differs from the initial version.

7.6 Trustworthiness, Reflexivity, and Ethics

Several strategies will support methodological trustworthiness. Data-source triangulation will connect classroom observations, teacher accounts, co-design records, artifacts, and learner-response evidence. Prolonged engagement across two cycles will enable analysis of practice over time rather than from isolated observations. Negative cases including adaptations that fail, produce unexpected consequences, or contradict the framework will be actively examined. Teachers will be invited to comment on interpretive summaries and proposed design revisions,

particularly where researchers' interpretations concern teachers' rationales or contextual constraints.

An audit trail will preserve successive versions of the framework, associated tools, analytic decisions, and evidence supporting major revisions.

Researcher reflexivity is particularly important because researchers will participate in co-design while simultaneously studying implementation. Researchers will therefore maintain reflexive records concerning their assumptions, interactions with teachers, design influence, and emerging interpretations. Where feasible, analytic responsibilities will be distributed so that not all evidence is interpreted solely by the researcher most directly involved in its generation.

Ethical approval will be obtained from the relevant institutional and educational authorities before fieldwork. Teachers will provide informed consent, and appropriate parental consent and student assent procedures will be followed for student participation and classroom video. Participation will be voluntary, and withdrawal procedures will be clearly communicated.

Student data will be pseudonymized and securely stored. Video and other identifiable data will be held on encrypted, access-controlled systems in accordance with institutional requirements. Because classroom observations concern professional practice, individual teacher evaluation will not be reported to school management. Particular care will be taken to ensure that participation in the research does not become an informal performance-management mechanism.

8. Anticipated Outputs and Evidence Requirements

Because fieldwork has not yet been conducted, this protocol reports no empirical findings. Rather than presenting a conventional Findings section populated with anticipated results, the study specifies in advance what evidence would be required to support its principal categories of claim. A claim concerning teacher enactment will require converging evidence from repeated classroom observations and teacher accounts. Observation alone may demonstrate what occurred but cannot necessarily establish why a teacher acted; interview evidence alone may establish perceived intention but cannot demonstrate enactment. A claim concerning framework usability will require evidence of actual engagement with the relevant design component together with teachers' accounts of how it supported or obstructed their work. Non-use will be investigated rather than automatically interpreted as evidence of poor design. A claim concerning contextual constraints will distinguish between reported constraints and directly observed manifestations of those constraints. For example, teachers may report insufficient time, while observation and planning records may show how time pressure actually changes adaptive decision-making. A claim concerning framework evolution will require a traceable chain connecting classroom or co-design evidence to the modification of a framework component or theoretical assumption. Finally, a claim concerning educational meaningfulness will require evidence beyond the visibility or frequency of adaptation. The analysis will examine whether adaptations were responsive to identified needs and whether subsequent evidence indicates improved understanding, participation, or learner independence. No causal claim concerning student outcomes will be made from the proposed design. Any changes observed across cycles will be interpreted as within-case patterns associated with the evolving

design and context, not as estimated intervention effects. The revised framework emerging from Cycle 2 will therefore be reported only after analysis. The protocol does not specify in advance what the “final” ATF will contain, because doing so would undermine the evidentiary logic of DBR. Any expectation derived from the literature will be treated as a design conjecture to be examined, not as an anticipated finding.

9. Theoretical and Practical Contributions

The study is designed to contribute at three interconnected levels; First, it contributes to the conceptualization of adaptive teaching by examining whether a recursive architecture linking anticipation, interpretation, instructional response, contingency, formative evaluation, and recalibration adequately represents adaptive classroom decision-making. Classroom evidence may confirm this architecture, but it may also reveal missing functions, unnecessary distinctions, or relationships among functions that require theoretical revision.

Second, the study contributes to understanding the translation of educational theory into professional practice. Rather than conceptualizing the theory–practice gap as a one-directional problem in which teachers fail to implement research correctly, the DBR process examines translation bidirectionally. Theory informs design, but situated professional practice also exposes limitations in theoretical representation and generates grounds for refinement (Korthagen & Kessels, 1999; McKenney & Reeves, 2018).

Third, the study contributes methodologically by making the evidence-to-revision relationship explicit. Each consequential modification to the ATF will be linked to documented evidence and theoretical reasoning. This approach responds to a recurrent challenge in DBR: demonstrating not simply that a design changed, but how iterative changes generated more transferable knowledge (Anderson & Shattuck, 2012).

9.1 Provisional Design Principles

The literature informing the initial ATF suggests several provisional design principles. These are treated as design conjectures rather than findings and will be retained, revised, qualified, or rejected according to evidence generated across the DBR cycles.

DP1. Responsiveness over variation.

Adaptive teaching should be evaluated by the correspondence between learner evidence and instructional response rather than by the amount of instructional variation observed.

DP2. Proportionate support.

Adaptive responses should provide sufficient support to address an identified need while avoiding unnecessary intervention and preserving opportunities for learner independence (van de Pol et al., 2010, 2015).

DP3. Shared purposes with flexible pathways.

Adaptation should preserve meaningful participation in common curricular purposes while permitting variation in support, representation, pacing, process, or demonstration where educationally justified (Florian & Black-Hawkins, 2011).

DP4. Evidence embedded in instruction.

Adaptive decision-making should rely on brief and recurrent evidence generated through ordinary teaching and learning rather than depend exclusively on separate diagnostic events (Black & Wiliam, 1998, 2009).

DP5. Professional judgment remains central.

Design tools should make evidence and decision processes more visible without replacing teachers' interpretation of learners and contexts (Goodwin, 1994; Shulman, 1987; van Manen, 1991).

DP6. Reflection must connect to subsequent action.

Reflection becomes educationally consequential when evidence from one adaptive episode informs immediate recalibration or subsequent planning.

DP7.

Local adaptation should preserve theoretical mechanisms. Co-design should permit teachers to modify tools and routines for contextual fit while preserving or explicitly challenging the framework's core mechanisms.

These principles are deliberately expressed at a higher level of abstraction than specific ATF tools. Planning templates, observation prompts, or scaffolding menus may be context dependent; the design principles specify the mechanisms that those tools are intended to instantiate.

9.2 Implications for Teacher Education

If the framework proves sufficiently usable and theoretically coherent, it may provide a structure for practice-based teacher learning. Its potential value lies less in giving teachers another checklist than in making adaptive reasoning available for professional discussion, observation, rehearsal, and reflection.

In preservice teacher education, the framework could organize approximations and representations of practice (Grossman et al., 2009). Prospective teachers could examine classroom episodes by asking what evidence of learner need was available, how it was interpreted, why a particular response was selected, whether the support was contingent, and what subsequent evidence justified maintaining, fading, or changing it.

In school-based professional learning, the ATF could similarly provide a shared language for collaborative planning, video analysis, lesson study, mentoring, or peer observation. Such applications would align with research emphasizing professional vision and practice-embedded teacher development (Ball & Forzani, 2009; van Es & Sherin, 2008).

These implications remain conditional. The DBR study must first establish whether teachers themselves find the framework useful for organizing professional judgment without imposing excessive cognitive or workload demands.

10. Limitations, Transferability, and Future Research

Several limitations are inherent in the proposed design; first, the manuscript is a research protocol. No claims concerning framework effectiveness, teacher development, or student

outcomes can be made until the proposed fieldwork and analysis have been completed. Second, the small purposive sample prioritizes depth, iteration, and mechanism over statistical generalization. Eight teachers in two schools cannot represent the diversity of educational systems, subjects, or learner populations. Third, researcher participation is simultaneously a methodological strength and a potential source of influence. Researchers will contribute to co-design, implementation support, and interpretation. Reflexive documentation and distributed analytic responsibilities can make that influence visible but cannot remove it. Fourth, the study does not permit strong causal inference concerning student outcomes. Changes in learning or participation may reflect teacher development, classroom conditions, curriculum, cohort differences, or other factors alongside the evolving framework. Fifth, classroom observation may alter teachers' behavior, particularly early in the study. Repeated observation may reduce but cannot eliminate reactivity. Sixth, voluntary participation may produce a sample disproportionately interested in adaptive teaching or professional experimentation. Finally, framework complexity itself constitutes an empirical risk. If the ATF requires excessive planning, documentation, or cognitive effort, its theoretical coherence will not compensate for poor classroom usability. Such evidence would constitute grounds for redesign rather than a failure of teachers to implement the model.

Transferability

Transferability will be pursued through analytic rather than statistical generalization. Detailed description of participating schools, classrooms, teachers, implementation conditions, and design changes will enable readers to judge the relevance of findings to other settings (Lincoln & Guba, 1985). A distinction will also be maintained between design principles and local design instantiations. A principle such as contingency may transfer across contexts, whereas the specific prompt card or planning template used to support contingency may not. Reporting both levels is necessary if other researchers or practitioners are to adapt the ATF without reproducing context-specific tools uncritically. The inclusion of primary and secondary settings provides a limited internal test of whether core mechanisms remain recognizable across educational levels. It does not establish generalizability, but differences between the two settings may help specify boundary conditions for subsequent research.

Future Research

If the two-cycle DBR produces a coherent and usable revised framework, subsequent research should move beyond initial design development. Larger multi-site studies could examine how the ATF is enacted across different subjects, school systems, and learner populations. Where appropriate, quasi-experimental or experimental designs could then investigate effects on selected student and teacher outcomes.

Mechanism-focused research should examine whether the hypothesized processes underlying the ATF particularly contingency, fading, formative responsiveness, and transfer of responsibility predict meaningful changes in learner participation, understanding, and independence. A further line of research should investigate teacher learning itself: whether sustained engagement with the framework changes professional noticing, interpretation of learner evidence, and adaptive expertise. Finally, cross-cultural DBR is necessary because assumptions about learner diversity, teacher authority, inclusion, differentiation, and professional judgment are institutionally and culturally situated. Such research should therefore

examine not merely whether the framework “works” elsewhere but which of its theoretical mechanisms remain stable and which require reconceptualization.

11. Conclusion

The theory–practice gap in adaptive teaching is not adequately understood as a simple failure to transfer research into classrooms. Educational theory necessarily abstracts from particular situations, whereas teaching requires professionals to interpret incomplete evidence and act under conditions of diversity, uncertainty, and institutional constraint. Bridging the two therefore requires more than disseminating principles: it requires designs through which principles can be enacted, examined, contested, and revised. This paper has proposed a design-based research protocol for developing such a bridge through the Adaptive Teaching Framework. The initial ATF organizes adaptive teaching around six recursive decision functions: planning for diversity, interpreting learner need, selecting an adaptive response, enacting and calibrating support, evaluating learner response, and reflecting and recalibrating instruction. These functions integrate formative evidence, contingent scaffolding, professional judgment, and inclusive participation within a common decision architecture. The proposed two-cycle DBR will not treat this initial architecture as a finished model. Its central empirical task is to determine what happens when the framework encounters classroom practice: which distinctions teachers find meaningful, which components become usable routines, which assumptions fail under contextual pressure, and which unanticipated practices require theoretical reconsideration. An explicit evidence-to-revision audit trail will connect those observations to changes in the framework. Accordingly, the principal intended contribution is neither a universal teaching model nor an efficacy claim. It is an empirically revisable account of adaptive teaching as professional decision-making, together with design principles specifying how theoretical mechanisms can be supported in authentic classrooms. The study thereby conceptualizes the relationship between theory and practice as reciprocal: theory structures what researchers and teachers initially design and notice, while practice provides evidence through which theory itself must remain open to revision.

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