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Review Article

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Using *the Formative 5 in Action* to Equip Future Teachers for Effective Math and Science Instruction

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Introduction

In an era of high accountability, growing classroom diversity, and increasing emphasis on deep conceptual understanding, particularly in STEM disciplines, formative assessment has become a cornerstone of effective teaching [1]. Nowhere is this more evident than in the preparation of preservice teachers in mathematics and science methods courses, where the ability to assess student learning in real time is critical for fostering responsive, equitable, and data-informed instruction [2].

As the landscape of PK-12 education continues to evolve, mastering formative assessment techniques empowers future educators not only to track student progress, but also to adjust instruction to meet diverse learner needs and promote academic success. *The Formative 5 in Action* by Francis "Skip" Fennell, Beth McCord Kobett, and Jonathan Wray (2024) [4] offers an accessible, research-based, and deeply practical framework that meets this need. Rooted in everyday classroom realities and supported by decades of research, the book outlines five key formative techniques that enable novice teachers to gather meaningful evidence of student thinking and use it to guide instructional decisions.

This paper explores how *The Formative 5 in Action* equips teacher candidates with the tools, mindsets, and techniques essential to both coursework and classroom practice. It also extends the conversation by examining the broader relevance of the Formative 5 across content areas and articulating key implications for teacher education policy and future research.

Literature Review

Formative assessment, sometimes referred to as "assessment for learning," has been widely documented as a powerful tool to improve student achievement and deepen engagement [4,5]. In mathematics and science classrooms, where emerging understandings can accumulate quickly, formative techniques are particularly effective in catching and correcting learning gaps [6]. Teacher preparation programs are increasingly tasked with developing candidates' abilities not just to plan instruction, but to adjust it responsively—a skill that hinges on the strategic use of ongoing assessment.

Despite this growing focus, many preservice teachers report discomfort or lack of clarity around using formative assessments in real-time classroom settings. This signals a need for models that are both practical and grounded in research. *The Formative 5* meets this need by providing clearly defined, replicable techniques that can be integrated into any lesson or unit, thereby supporting a shift from assessment *of* learning to assessment *for* learning.

Theoretical Framework

The foundation of *The Formative 5 in Action* rests on several key learning theories:

1. Constructivism (Piaget)

The "Show Me" and "Exit Task" techniques invite students to construct their own meaning and demonstrate understanding in ways that align with constructivist learning theory [7]. Instead of passive absorption, students actively represent and manipulate ideas [8].

2. Sociocultural Theory (Vygotsky)

The interview and observation techniques mirror the importance of scaffolding and responsive interaction within the Zone of Proximal Development (ZPD). Teachers adjust instruction based on direct interaction, co-constructing meaning with students [9].

3. Assessment for Learning (AfL) Framework

As outlined by Wiliam (2011) [10], AfL focuses on using assessment to inform instruction, promote metacognition, and provide feedback that moves learning forward. *The Formative 5* aligns with this framework by offering feedback-rich, low-stakes, high-frequency techniques that enhance instructional responsiveness.

Together, these theories validate the Formative 5 as tools for facilitating deep learning, increasing student agency, and enabling data-informed instruction.

Meeting the Needs of Preservice Teachers in Math and Science Methods Courses

Math and science methods courses in colleges of education serve a critical dual role: they deepen preservice teachers' content knowledge while also developing their pedagogical and assessment competencies. These courses are often a preservice teacher's first opportunity to bridge theory and practice, making the selection of instructional resources particularly important. *The Formative 5 in Action* helps fulfill this role by offering practical, research-informed, and theoretically grounded strategies that candidates can apply immediately in field placements and future classrooms.

The five core formative strategies—Observations, Interviews, Show Me, Hinge Questions, and Exit Tasks—are each presented in the book with authentic K–12 classroom examples, planning templates, reflection prompts, and student work samples. These features enable candidates to visualize implementation, practice lesson planning, and critically analyze student thinking.

By engaging with these strategies, teacher candidates learn to:

- **Diagnose emerging conceptions**, particularly in complex STEM content areas
- **Encourage student discourse and justification**, aligning with NGSS and NCTM process standards
- **Make real-time instructional decisions** informed by evidence
- **Design equitable, differentiated assessments** for diverse learners

Crucially, the text emphasizes not just *what* to teach, but *how* to interpret and respond to student understanding—an essential competency for effective and equitable instruction. In doing so, *The Formative 5 in Action* becomes more than just a set of techniques; it becomes a toolkit for responsive pedagogy and professional growth.

Supporting STEM Integration and Instructional Agility

While the Formative 5 were originally developed for math classrooms, the principles behind them are broadly applicable across content areas—including science. Techniques like the use of hinge questions and exit tasks are essential in inquiry-based science instruction for gauging conceptual understanding and identifying emerging conceptions [11]. The emphasis on oral interviews and observation also aligns well with Next Generation Science Standards (NGSS), which prioritize student discourse, modeling, and argumentation from evidence [12,13].

For teacher candidates preparing to teach STEM-integrated units, *The Formative 5 in Action* provides a flexible framework for capturing student thinking at multiple stages of the learning process. It allows them to move beyond summative assessments and embrace classroom-based formative processes as drivers of deeper learning and equity.

Classroom Readiness and Instructional Decision-Making

Pre-service teachers often struggle with making real-time instructional decisions based on student data. *The Formative 5 in Action* helps bridge this gap by modeling how to "listen" to student thinking and adjust instruction accordingly. This is especially important in mathematics and science, where partial understandings can derail conceptual learning if not identified and addressed quickly [5,14].

Moreover, the book's emphasis on using assessment to support learning rather than sort or rank students, aligns with a strengths-based and inclusive teaching philosophy [15]. Through this lens, teacher candidates learn how to monitor and interpret student work as evidence of thinking and reasoning, rather than merely evaluating for correctness. This shift not only fosters a growth mindset in learners but also supports culturally responsive teaching by valuing the diverse ways students make sense of content.

Alignment with Research and Best Practices

Fennell et al's work is widely cited and validated through observational and empirical research. For instance, the development and use of the "Look-For Protocol" by Bostic et al. (2019) [14] confirms the practical value of formative observation tools in supporting instructional improvement. Cowie and Bell's (2001) [6] foundational research on formative assessment in science further corroborates the cross-disciplinary utility of such frameworks.

The book also aligns with recent shifts toward performance-based and competency-based education models in teacher preparation [16]. By centering formative assessment, it promotes the idea that teacher candidates themselves must become assessors of learning, not just deliverers of content.

Implications for Other Content Areas

Although designed with mathematics in mind, the *Formative 5* techniques are readily adaptable to a wide range of disciplines. Below is a synthesis of how these techniques can support classroom-based formative assessment across literacy, social studies, and the arts, in addition to science and math.

Science Education

- **Observations** of student interactions in labs and experimental setups.
- **Interviews** about hypothesis formation and claim-evidence reasoning.
- **Show Me**: Model systems like the water cycle or illustrate chemical reactions.
- **Hinge Questions** for quick conceptual checks (e.g., "What will happen if...?").
- **Exit Tasks** summarizing findings or explaining phenomena.

Literacy

- **Observations** during partner reading or discussion groups.
- **Interviews** to gauge comprehension, inference-making, or text analysis.
- **Show Me** tasks such as identifying main ideas with text evidence.
- **Hinge Questions** on vocabulary, theme, or character development.
- **Exit Tasks** summarizing the plot or personal reflections on reading.

Social Studies

- **Observations** during role-playing or debates about historical events.
- **Interviews** exploring primary source analysis.
- **Show Me**: Visual timelines or mind maps of causes and effects.
- **Hinge Questions**: "Which action best illustrates democratic values?"
- **Exit Tasks** reflecting on civic implications or personal connections.

The Arts

- **Observations** of technique development or creative choices.
- **Interviews** about artistic intention or emotional expression.
- **Show Me**: Ask students to revise or annotate their work.
- **Hinge Questions** on theory, media, or historical context.
- **Exit Tasks** expressing reflection or critique in writing or visuals.

Although *the Formative 5 in Action* was developed with a focus on mathematics, its core techniques—observations, interviews, Show Me tasks, hinge questions, and exit tasks—are highly adaptable to other disciplines. From exploring student interpretations of primary sources in social studies to analyzing scientific reasoning in lab settings, these tools enable educators to elicit student thinking in meaningful ways. In literacy instruction, for example, they can be used to assess comprehension, vocabulary use, or author's craft. What unites these examples is a shared pedagogical goal: fostering deeper learning by making students' ideas visible and using those ideas to inform responsive teaching. As such, the Formative 5 provides a flexible, research-informed framework that holds promise not only for STEM methods courses, but for teacher preparation across the curriculum.

Programmatic and Policy Implications

For colleges of education, adopting *The Formative 5 in Action* within methods courses offers several benefits:

- Aligns with Educative Teacher Performance Assessment (edTPA) rubrics that prioritize academic language and formative assessment.
- Supports Council for the Accreditation of Educator Preparation (CAEP) accreditation standards, especially Standard 1: Content and Pedagogical Knowledge.
- Bridges the gap between university coursework and clinical practice by providing tools teacher candidates can use immediately in placements.
- Prepares future teachers for evaluation systems (e.g., Danielson Framework) that emphasize responsive teaching and assessment literacy.

Districts and teacher residency programs may also consider integrating the Formative 5 into induction programs and professional development models.

Future Directions: Research and Classroom Impact

In today's diverse and rapidly evolving educational landscape, teacher adaptability and responsiveness are more essential than ever. *The Formative 5 in Action* equips future educators with classroom-based formative assessment techniques that are flexible, non-prescriptive, and centered on student thinking. Whether teaching in high-needs urban schools, inclusive classrooms, or STEM-focused environments, these techniques enable teachers to ground their instruction in evidence and empathy. The Formative 5's framework empowers preservice teachers to engage in reflective habits—planning, observing, analyzing, and adjusting—that foster responsive, equitable instruction across all grade levels.

Yet while the Formative 5 is widely implemented in teacher education, several important questions remain unanswered. These open pathways for further inquiry and instructional innovation:

- **Longitudinal studies** are needed to track how preservice teachers internalize and sustain classroom-based formative assessment practices across their careers.
- **Comparative research** could explore the framework's differential impacts across STEM and non-STEM subject areas.
- **Equity-focused studies** are essential for understanding how classroom-based formative assessment influences learning outcomes for historically marginalized student populations.
- **Design-based research** could inform the development of digital tools that scaffold real-time data collection, analysis, and instructional decision-making using the Formative.

These areas of research can directly inform curriculum development in teacher preparation programs, induction supports, and professional development initiatives. As educators and researchers continue to confront the challenges of instructional equity, classroom complexity, and student variability, the need for practical, evidence-based formative assessment frameworks like the Formative 5 will only grow.

Conclusion

The Formative 5 in Action represents a critical bridge between theory and practice for preservice teachers learning to assess student understanding, monitor and adjust instruction, and foster conceptual learning—particularly in mathematics and science. Yet its value extends well beyond these disciplines. By offering strategies that are grounded in research, easy to implement, and adaptable across grade levels and subject areas, the book provides a powerful framework for formative assessment across the curriculum.

For colleges of education, instructional coaches, and curriculum designers, *The Formative 5* offers a promising model grounded in research and adaptable to varied instructional contexts. It equips teacher candidates not only with foundational content knowledge but also with the pedagogical agility, assessment literacy, and reflective habits needed to thrive in today's complex classrooms. With its emphasis on equity, responsiveness, and student-centered learning, the Formative 5 framework offers a scalable and sustainable model for preparing educators who are ready to lead meaningful, inclusive, and data-informed instruction in any educational setting.

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