



The impact of formative assessment on student achievement: A study of the effects of changes to classroom practice after a comprehensive professional development programme



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ABSTRACT

A random sample of 22 Year 4 teachers in mathematics from a middle-sized Swedish municipality participated in a teacher professional development programme in formative assessment. The content of the programme was formative assessment conceptualised as a unity of different, integrated strategies. The study examines the effects on student achievement of the changes in the teachers' formative classroom practice that followed the professional development input. Results show that, after controlling for pretest scores, the classes in the intervention group significantly outperformed the classes in the control group in a posttest administered one school year after the end of the programme ($p = 0.036$, $d = 0.66$). The study contributes to the understanding of under-studied areas of the impact of professional development in formative assessment, and the impact of teacher practice based on formative assessment conceptualised as a unity of different formative assessment strategies.

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1. Introduction

1.1. Background

In their influential review of effects of formative assessment Black and Wiliam (1998) demonstrated that large-scale student achievement gains are possible when formative assessment is employed in classroom practice. They defined formative assessment as “encompassing all those activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged” (Black & Wiliam, 1998, pp. 7–8). This definition affords several different foci in carrying out formative assessment, and accordingly Black and Wiliam's review included studies examining different strategies for carrying out formative assessment. Some of these strategies were researched using the term formative assessment, while some carried denotations such as feedback. Other research reviews focusing on each of these strategies have confirmed their potential for enhancing student achievement. Such research includes reviews on feedback (Hattie &

Timperley, 2007; Shute, 2008), self-regulated learning, which includes self-assessment and subsequent actions to attain the learning goals (Dignath & Büttner, 2008; Ross, 2006), and peer-assisted learning including peer-assessment and subsequent feedback (Rohrbeck, Ginsburg-Block, Fantuzzo, & Miller, 2003; Van Zundert, Sluijsmans & Merriënboer, 2010). Research reviews including a specific focus on mathematics have also shown strong relationships between student achievement in mathematics and teachers' adjustment of teaching based on collected evidence of student learning (National Mathematics Advisory Panel, 2008; Yeh, 2009) and self-regulated learning (Dignath & Büttner, 2008).

However, researchers have questioned the quality of some studies that provide the evidence base for the effectiveness of formative assessment, noted that not all studies report large-scale effects on student achievement, and that some interventions consisting of formative assessment have not produced any effect on student achievement at all (Bennett, 2011). In addition, reviews show that many of the studies demonstrating the impact of formative assessment on student achievement are rather brief in duration (e.g. Dignath & Büttner, 2008). This makes the extent the observed teacher practices and increased achievement could be sustained over time unclear. As an example of a study examining the sustainability of enhanced achievement, Dresel and Haugwitz (2008) found a significant positive effect of support for students'

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self-regulated learning on student achievement at the end of an intervention of 5–9 sessions. In a follow-up test 5 months later the difference in achievement between the intervention group and control group was no longer significant. Hence, studies on how to support teachers in their implementation of formative assessment as a regular and inherent part of their common teaching practice, and its impact on long-term learning, are necessary. Furthermore, studies comparing the effect of formative assessment on different kinds of mathematical knowledge and skills are rare (Ryve et al., 2015).

Formative assessment interventions by regular teachers based on professional development seem to entail significant difficulties. Attempts to promote formative assessment have frequently been unsuccessful in accomplishing a substantially developed formative assessment practice (De Lisle, 2015; Hume & Coll, 2009; James & McCormick, 2009; Schneider & Randel, 2010; Wylie & Lyon, 2015), to the extent that increased student achievement was obtained (Jönsson, Lundahl, & Holmgren, 2015; Randel, Apthorp, Beesley, Clark, & Wang, 2016; Schneider & Randel, 2010). In addition, there is a lack of empirical studies examining the characteristics of professional development programmes in formative assessment and their impact on both teacher practice and student achievement (Schneider & Randel, 2010). Thus, a strong research base supporting how to effectively help teachers to implement a high quality formative assessment practice is lacking (Schneider & Randel, 2010; Wiliam, 2010).

Another issue with relevance for the impact of formative assessment is its conceptualisation. Formative assessment strategies share the common core of modifying teaching and learning based on identified student learning needs, but may include an emphasis on different aspects of formative assessment. Some researchers study formative assessment conceptualized as teachers using tests or questioning to gather evidence of student learning needs, with subsequent feedback or adjustment of instruction to fit these needs. Within this approach to formative assessment studies have shown the interdependence and important roles in high-quality formative assessment played by the three processes of collecting information about the students' learning, the teachers' interpretation of the collected evidence and their instructional use of the interpreted information (Heritage & Heritage, 2013; Schneider & Gowan, 2013; Van de Pol, Volman, & Beishuizen, 2011). Other researchers focus on the feedback given to students based on the gathered evidence on student learning. This formative feedback can be defined as "information communicated to the learner that is intended to modify his or her thinking or behavior for the purpose of learning" (Shute, 2008, p. 154). The feedback may contain different types of information. It may for example be directed at the task solution, task solution processes or self-regulatory processes (Hattie & Timperley, 2007). It may also be given in different manner (controlling or invitational), delivered by different agents (e.g. teacher or computer), and at different points in time (immediate or delayed). Effective feedback includes providing students with useful information about the goals to attain, the current progress towards these goals, and how to reduce the gap between current and desired level of attainment (Hattie & Timperley, 2007). Another research focus is the students' role in the formative assessment process. In addition to only responding to teachers' feedback and adapted instruction this role may be as proactive self-regulated learners, which includes self-assessment and subsequent actions to attain the learning goals. Such self-regulated learning involves the processes of planning (including goal setting), monitoring, reflecting on and modifying one's learning (Zimmerman, 2002). Studies have shown that all of these processes play important roles for the effectiveness of self-regulated learning (Kostons, van Gog, & Paas, 2012; Pieger,

Mengelkamp, & Bannert, 2016; Zimmerman & Bandura, 1994). The students' role in the formative assessment practice may also be to support each other's learning through peer-assisted learning, involving peer-assessment and subsequent peer feedback through explanations and suggestions to peers on how they can act to reach their learning goals (Gielen, Peeters, Dochy, Onghena, & Struyven, 2010).

Since teachers' feedback and adapted instruction, based on gathered information about student learning, and students' self-regulated and peer-assisted learning are complementary components it appears that a classroom practice integrating these strategies into a unity would open up extended learning opportunities, and would have the potential for further enhancement of student achievement. There exists different but similar suggestions of how such practice may be conceptualised and operationalized (Arter, 2009; Wiliam & Thompson, 2008). However, the effects of such practice are not well known. For example, as of yet we have not found any studies using randomized samples and control groups to study the effect of this way of conducting formative assessment on student longer-term achievement in mathematics. The very few published attempts at supporting a random selection of teachers in implementing formative assessment as a unity of different formative assessment strategies do not seem to have had an impact on student achievement (Bell, Steinberg, Wiliam, & Wylie, 2008; Randel et al., 2016). However, the available evidence indicated that both the extent and fidelity of the programme implementation in these two studies was limited. Thus, they do not provide evidence about the impact of formative assessment on student achievement. They do though provide evidence on the difficulty of professional development, in formative assessment as a unity of integrated formative assessment strategies, making an impact on teaching and student achievement.

1.2. Aim

The study reported in this article is part of a larger project examining the effects of a teacher professional development programme in formative assessment. A random sample of teachers participated in this professional development input, which was based on the idea of formative assessment as a unity of integrated strategies. In the present study we investigate the following research questions:

1. Does the formative classroom practice implemented by the teachers who participated in the professional development programme have an effect on student achievement?
2. Does this formative classroom practice exert a particular effect on the students' proficiency in solving tasks requiring only the application of procedures, and on tasks also requiring other mathematical processes?

Desimone (2009) suggests a conceptual framework for studying teachers' professional development including a core theory of action following four steps: (1) teachers experience effective professional development, (2) the professional development increases teachers' knowledge and skills and/or changes their attitudes and beliefs, (3) teachers use their knowledge and skills, attitudes, and beliefs to improve the content of their instruction and/or their approach to pedagogy (4) the instructional changes foster increased student learning.

However, these steps (or change processes) may not always happen in this particular order. Guskey (1986) stated that change in teachers' attitudes and beliefs would happen after teachers have tested activities in the classrooms and experienced positive outcomes. Thereafter, a more lasting change in teachers' practice

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