The Ontario Action Researcher

IMPLEMENTING MULTIPLE ASSESSMENTS IN MATHEMATICS: AN ACTION RESEARCH STUDY OF ONE TEACHER AND HIS STUDENTS

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An action research study was conducted to document a classroom teacher's attempt to incorporate multiple assessments in a grade 9 applied mathematics class. A variety of data collection techniques were used, and through on-going analysis, factors emerged that facilitated (examining beliefs, resources, planning and organization) and impeded (time, lack of collaboration, curriculum content, students' weak literacy and problem solving skills, reporting to parents) implementation of multiple assessments. Students became less resistant once they saw benefits to their learning. While this study challenged our beliefs and practices, we discovered that future studies are needed to document what is happening in classrooms as teachers implement the reforms now taking place in mathematics.

Background

With the implementation of the Ontario grades 1-12 mathematics curricula in the late 1990s, the teaching of mathematics has shifted from an emphasis on procedures and skills to a focus on reasoning, problem solving, application of concepts, and communication. Lambdin (1998) believes with changes to curriculum and instruction that assessment also needs to change. Hence, curriculum, instruction, and assessment should be seamless and inseparably linked.

Sole reliance on traditional paper and pencil tests has served its purpose in the past when mathematics was viewed as the ability to manipulate procedural and computational skills (Lambdin & Forseth, 1996). Students who scored highly on traditional tests were believed to have strong mathematical abilities; however, the National Research Council (1989) concluded that students have difficulty thinking for themselves, solving problems, demonstrating number sense, and reasoning creatively (in Lambdin, 1993). Also, students who are test anxious (i.e., not proficient test takers) are disadvantaged.

Each grade 9 student in Ontario selects either the academic, applied, or essentials stream for mathematics. Students are allowed to move between streams (e.g., applied to academic; essentials to applied; academic to applied). It should be noted that students enrolled in the applied stream for mathematics can still attend university, just not for "math-rich" programs such as engineering or physical science. All grade 9 applied and academic mathematics students write the Educational Quality and Assessment Office (EQAO) test, administered near the end of the semester. Although not

a graduate requirement, each student receives a report. School results are published (often ranked) in the media. The former Conservative government legislated the creation of EQAO to help ensure accountability for the education system.

The Ontario curriculum mandates that formative assessment be used in all subject disciplines to support student learning. That is consistent with Davies' (2000) belief that assessment is *for* learning rather than *of* learning. The reform efforts are supported by the National Council of Teachers of Mathematics (NCTM) (e.g., *Principles and Standards for School Mathematics* (2000)). In *Assessment Standards for School Mathematics* (1995), the NCTM recommends that student performance be based on established criteria; students are provided with multiple opportunities to demonstrate their learning; and they are active participants in the process.

Benefits of Alternative Assessments

Borasi & Rose (1989) state that journals allow students to express, reflect, and consolidate their knowledge, feelings, and beliefs of mathematics in order to be aware of their strengths and misconceptions; provide immediate feedback for the teacher to assess students' learning; and strengthen student-teacher relationships by using journals for open dialogue. Jurdak & Zein (1998) add that students' conceptual and procedural understandings are enhanced through journals, which "lends support to the theories of writing that propose a dialectic relationship between writing and learning" (p. 416).

Asturias (1994) describes the benefits of student portfolios as the active role placed on students by selecting which pieces to include; the reflection students have on their progress and areas for improvement; and portfolios are a record of student achievement, which allows the teacher to make changes to program delivery. Kuhs (1994) adds, "portfolios in mathematics classrooms may not only be a way to assess learning but an important outcome of instruction itself" (p. 335).

Two benefits of performance assessment are student motivation and teacher empowerment (Rudner & Boston, 1994). The researchers believe that motivation increases when students are provided with responsibility for their own learning, make connections, and have opportunities to collaborate with others to think, reason, and communicate. Chen (1999) adds that performance tasks enhance students' understanding and self-confidence of mathematics since they are "able to internalize and transform the learning material into something that has personal relevance and meaning" (p. 3).

Theoretical Framework

The Ontario mathematics curriculum has constructivist foundations. Vygotsky (1987) believes that people reorganize their web of meaning when they connect new knowledge with current knowledge. Sfard (2003) adds, "without social interaction in human learning, no conceptual learning would be possible" (p. 371). Sierpinska (1998) describes the teacher's role as a facilitator since "mathematics cannot be taught by telling" (p. 56). Descriptors such as "formulate," "interpret," "pose," "collect," and "analyze" suggest that a variety of instructional and assessment strategies be used.

Raymond's "Mathematics Beliefs and Practices Model" (1997) provides a framework for critically examining beliefs and practices. Before commencing the study, I[1] applied Raymond's "Criteria for the Categorization of Teachers' Beliefs About the Nature of Mathematics, Learning Mathematics, Teaching Mathematics, and Mathematics Teachers' Teaching Practice" to determine where I was positioned on the continuum using her five-point scale. Critical reflection of beliefs and practices is important since studies (e.g., Lock & Munby, 2000; Suurtamm, 1999; Cheng, 1999; Borko, Mayfield, Marion, Flexer, & Cumbo, 1997) found that participants' beliefs and practices were not aligned, resulting in the reforms not being implemented as intended or even ignored. Long and Benson (1998) remind us that aligning assessment with curriculum and instruction does not occur naturally, while Edwards (2000) states that

[1] The use of "I" and "my" refer to the first author.

teachers who are successful in changing their practices do so through their commitment to change as well as visualizing what that change might look like.

Research Questions

A review of recent literature states the benefits to alternative assessments, yet the participants in the studies of Lock & Munby (2000), Suurtamm (1999), Cheng (1999), Borko, et al. (1997) did not align their beliefs and practices. After critical reflection of my own beliefs and practices of teaching and learning mathematics, the specific research questions for this study are:

- What are the factors that impede or facilitate the implementation of multiple assessments?
- What are students' views of being assessed through multiple assessments?

Research Methodology/Data Sources

This qualitative study is based on action research. Berg (2001) states that action research has been used increasingly to investigate classroom teaching practices since both the researcher (educator) and subjects (students) are highly engaged in the study. Also, teachers enhance their understanding of knowledge and practice, resulting in making informed decisions for their students. I chose action research as a methodology since I was interested in documenting my own journey of changing assessment practices. Although various models exist, Berg states that all models view the action research process as a spiral. The cycle continues at a higher level, to improve pedagogy and student achievement.

This study, supervised by the second author, took place in a grade 9 applied mathematics class in an urban south-eastern Ontario community. This particular class initially had 12 students, which grew to 15 students, several weeks into the course. Three of these students were identified as having behavioural exceptionalities and two other students having communication exceptionalities. A case study approach of changing the first author's assessment practices followed a six-stage process as described by Shaw and Jakubowski (1991). Students completed three questionnaires that included space for them to share their feelings of specific alternative assessments, purpose and value of specific assessments to learning mathematics, as well as their concerns. Field notes were maintained to document thoughts, reactions, next steps, issues, concerns, and interpretation and analysis of the data, along with informal conversations with students. Data analysis followed Patton's (1990) three stages: organization, description, and interpretation. Trends in the data were annotated and described.

Findings

Using Raymond's criteria, I hold non-traditional beliefs of the nature of mathematics; primarily non-traditional beliefs about teaching and learning mathematics; and, primarily traditional practices. Although my beliefs are quite non-traditional, my practices are consistent with the traditional practices of American teachers in the grade 8 Third International Mathematics and Science Study video study, which concluded that "teaching is cultural" (Stigler & Hiebert, 1999):

> First answers were given for the previous day's assignment. A brief explanation, sometimes none at all, was given of the new material, and problems were assigned for the next day. The remainder of the class was devoted to students working independently on the homework while the teacher moved about the room answering questions. The most noticeable thing about math classes was the repetition of this routine. (Welch, 1978, p. 6)

Five factors emerged that impeded the implementation of multiple assessments: time (additional half-course to teach that particular year as mandated by the provincial government; co-curricular activities; providing feedback to journals and creating rubrics; outside responsibilities as a journal

editor and textbook author); lack of collaboration (taught in isolation); curriculum content (difficult to implement alternative assessments in skills-based units such as number sense and algebra; challenging and packed curriculum); students (lacked prerequisite content and skills; not risk-takers; weak literacy and numeracy skills; several at-risk students); reporting to parents (stressful to evaluate student portfolios with report card marks due within 48 hours; Parents' Night in 4th week of school did not allow for presentation of portfolios). Three factors facilitated the implementation of multiple assessments: examining beliefs (use of Raymond's model before conducting the study); resources (ministry funding for graphing calculators, geometry computer software, textbooks); planning/organization (template to balance instruction, curriculum, and assessment; field journal for reflection).

Three student questionnaires were administered. The first questionnaire revealed that only four of the nine students who completed the questionnaire used journals and/or portfolios in grade 8. All students who wrote journals in grade 8 had negative experiences (e.g., "We had to write a page and you can't really write a page of how to do a problem so people would make something up to fill the page"). Students expressed resistance to writing journals in the grade 9 course (e.g., "I don't see anything besides extra work which we shouldn't have to do unless we're failing").

The second questionnaire revealed that students found portfolios an organizational tool, rather than a record of their growth. Journals, on the other hand, "show that you know how to explain the terms and rules of the question so the teacher knows that you understand something." Students did not express resistance with the alternative assessments since they believe these assessments could help compensate for test anxiety by raising their marks.

The responses on the final questionnaire were positive and encouraging. Six of the nine respondents stated that I should continue to use journals, portfolios, and performance tasks in future grade 9 classes since "it will help them (students)". Seven of the nine respondents stated that journal writing is an important tool for learning mathematics (e.g., "You get a question and have to solve it or pretend to explain it to someone and that helps"). Five students still viewed portfolios as an organizational tool, while the other four students think portfolios "show the teacher all the best work."

From this study, it seems that the *curriculum content* is the driving force to success in implementing multiple assessments, which occurred naturally in units that are problems-based (e.g., relationships, measurement, geometry). Units that focus on skill and procedural development (e.g., number sense, algebra, analytic geometry) resorted to traditional assessments such as quizzes and tests (although journals were used).

Significance

This study adds to the existing literature on classroom-based assessment and is timely for mathematics educators attempting to implement student-centred assessment. Whether teachers, as in Ontario, are mandated to align assessment with curriculum or instruction, or choose to incorporate assessments besides tests and examinations, this study provides them with a case study of one high school mathematics teacher. Battista (1994) reminds us that teachers, often products of traditional instruction, are mandated to implement reforms using a "top-down" model. Hence, change can be a slow process, yet an important one to keep moving forward through plenty of professional development and collaborative experiences.

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