Formative Assessment

in High School Mathematics Classrooms

Final Research Report

August 19, 2013

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Project Overview

Introduction

In February 2012, the Alberta Assessment Consortium (AAC) received a grant from Alberta Education to support assessment related professional learning needs of high school mathematics teachers within selected school sites over a three semester time frame. Teachers in the sixteen High School Flexibility Enhancement Project schools formed the target population for this project.

As part of the Terms of Reference, AAC was required to
- conduct a research study to explore the impact of formative assessment practices and professional learning practices on teacher practice, student engagement, and student achievement;
- develop samples of high school mathematics assessment tasks and rubrics along with samples of student work; and
- create a set of videos documenting promising assessment practices in high school mathematics classrooms.

With these goals in mind, the AAC provided secondary mathematics teachers with access to a coach, with both assessment and mathematics expertise, to provide on-site support to teacher participants for the duration of the project. Some teachers participated in the professional learning component of the project, some participated in the research portion of the project, and some teachers elected to participate in both the professional learning and the research components. Aside from large group professional learning sessions that were scheduled as part of a school/jurisdiction professional learning event, teachers within each school self-selected for this project, including determining the extent to which they would be involved.

Project Outline

The AAC seconded two facilitators/coaches to guide the day to day work of the project. One coach was assigned to support project schools in northern Alberta and the other was assigned to support project schools in southern Alberta.

The AAC used a sustained coaching model of teacher professional development (PD) in this project[1]. Professional learning opportunities within a sustained coaching model are
- provided to teachers in their school setting;
- focused on enhancing professional practice;
- responsive to individual teacher needs; and
- provided over a period of time.

The coaches initiated contact with the schools in their designated areas, coordinated meetings with school leaders and teachers, and provided them with an overview of the AAC project. As the sustained coaching model is designed to be responsive to teacher needs, AAC coaches responded to individual school leader and teacher requests for the type and frequency of support they were interested in receiving.

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[1] A review of research literature on effective PD and the impact of formative assessment can be found on the AAC website at: http://www.aac.ab.ca/wp-content/uploads/2013/11/Lit_Review_Sustained_Coaching_Model_of_Teacher_PD.pdf

The types of professional learning support provided were as follows:
1. large-group informational PD sessions on formative assessment practices
2. small-group informational PD sessions on formative assessment practices
3. small-group working sessions developing performance assessment tasks and rubrics
4. one-on-one planning sessions
5. teaching demonstration lessons that integrated formative assessment strategies and performance assessment tasks
6. formal coaching sessions that included a lesson pre-conference, a lesson observation, and a lesson post-conference with teacher and coach

The majority of the coaching was completed through demonstration lessons and formal coaching sessions. Twelve of the sixteen schools engaged in some form of professional learning activity with the AAC coaches.

The AAC coaches visited each school from one to ten times during the duration of this project. Each of the formal coaching sessions that the AAC coaches held with teachers was either video or audio recorded. In addition, selected classroom lessons were also recorded in classrooms where teachers agreed to participate in the collection of video samples that had been requested by Alberta Education. The AAC obtained separate permission from these teachers, in addition to the ethics permission for the formal research. AAC also obtained permission from students and parents/guardians to include samples of student work and/or video footage of the students in the video portion of the project.

Research Outline

The intent of the research study was to determine the impact of the sustained coaching model of PD on teacher practice with respect to implementation of formative assessment strategies, and to identify specific changes in teacher practice and understanding of formative assessment. The initial research design was to include student engagement and achievement data but due to time restrictions and challenges with ethics approval procedures, students were not surveyed as part of this research project, nor were student data included. The choice was made to have the AAC coaches be the liaison between the researcher and the teachers to minimize inconvenience to teachers. The AAC coaches asked teachers if they wanted to be included in the research portion of the AAC project and then obtained research ethics permissions from those who agreed. The researcher obtained research ethics permissions from the school boards within which the teachers worked. For those teachers who agreed to participate in the research portion of the project, the video and audio recordings of their interactions with the AAC coaches were shared with the researcher. Footage of students and samples of student work were not included in the study, as ethics permissions were not obtained for those pieces. What follows in this report is a description of the research methods used to collect and interpret data, and a description of the findings.

Research Summary

Of the 16 schools that were invited to participate in the research portion of the project, teachers in 9 schools agreed. Permission to conduct research was granted from the school board within which each school was located and permission was also granted from each school. From those 9 schools, 18 teachers agreed to participate in the research project with the number of teachers in each school ranging from one to six. Each teacher participating in the research was teaching at least one high school mathematics course over the data collection period. Teachers from schools that accessed only the large or small group PD sessions were not included in the research report as they did not fully participate in

the sustained coaching model of PD. The number of times that the coaches interacted with the teachers on an individual basis varied from one time to eight times over the course of a year.

In addition to the recorded interactions between the AAC coaches and the teachers throughout the project, final or exit-interviews were conducted with teachers. During this interview, teachers were asked to speak about the following topics:

- whether or not their ideas about what constituted formative assessment changed over the course of the project;
- whether or not the model of PD that was used was effective; and
- what were some suggestions for improvement of the model.

There were instances where an exit interview with a teacher was not possible but the teacher's interactions with the AAC coach during the coaching process were still included in the analyzed data.

The only contact the researcher had with the schools or school divisions was to coordinate ethics permissions for the research project. The AAC coaches coordinated each of the interactions, planned the large and small group presentations, and led the exit interviews. The researcher had multiple conversations with the AAC coaches over the course of the project to confirm research questions and processes. Due to the multiple layers included in the AAC grant, continued communication between the AAC coaches and the researcher was essential in keeping the research data collection focused and to ensure that the research ethics processes were followed.

Data Analysis

The recordings of the coaching sessions between the AAC coach and the teacher that were identified as having relevant content were transcribed verbatim. The information included in the transcriptions was then coded by the researcher according to the following themes:

1. Description of the coaching process
2. Benefits of the coaching model of PD
3. Challenges with the coaching process
4. Changes teachers made in teaching practice due to the PD
5. Teachers' beginning formative assessment ideas
6. Teachers' ending formative assessment ideas
7. Benefits of formative assessment noted by the teacher
8. Challenges implementing formative assessment
9. Strategies used by the teacher as formative assessment
10. Adjustments that teachers would make to strategies that they tried
11. Changes in students or learning that teachers noticed

Information that did not relate to any of the above themes was not included in the analysis. If a section of a transcript was potentially viable in more than one category, a decision was made as to which category was most appropriate for the excerpt to be included, thus sections of the transcript were not included in more than one category.

Research Findings

As one of the goals of the larger AAC project was to provide professional learning opportunities for high school mathematics teachers to assist them to integrate formative assessment into their classroom instruction, the findings from this research study are presented in two major categories. The first category is with respect to the sustained coaching model of PD that was used in the AAC project. The second category is with respect to formative assessment understandings and practices of the teachers

that participated in the research portion of the project. In each category, benefits of engaging in the activity and challenges with implementing the activity are noted. Within the formative assessment category, additional topics are addressed that provide greater insight into teachers' understanding and use of formative assessment strategies.

The findings in each section are reported in different formats to reflect the quantity of comments that were coded in each theme. In some sections, numerous comments were provided by teachers and an illustrative comment reporting format has been used. In other sections, unique teacher comments have been included within the text. In another section, individual teacher responses are recorded in a table to reflect their understanding of formative assessment prior to and after participating in the project. In another section, illustrative examples have been provided.

Findings with Respect to Coaching Model of PD

As previously described, the sustained coaching model of professional development was used to support teachers in this project. Specific PD activities provided by the AAC coaches were also noted earlier in this report. The amount of time that the coaches spent with each teacher and at each school varied depending on the requests from the teachers and also depending on the timing of the school's initial response to the contact from the AAC facilitator. The first set of findings that are reported below are teacher interpretations of the benefits gained from, and the challenges with, implementing the sustained coaching model of PD.

Benefits of the Coaching Model

During exit interviews, teachers were asked specifically to respond to their perceived benefit of the coaching model that was used in this study. As the project was set up to be responsive to teacher requests, different levels of engagement with the coaches resulted. When the transcripts of the conversations were analyzed, the themes within the benefits were noted. Those themes are identified in the table below, along with the number of teachers that made comments within that theme, and illustrative comments from teachers.

Theme	# of teachers (out of 18)	Illustrative Comments
Having the same coach each time/relationship with coach	11	You have a really nice manner, and so I never felt like you were in there to judge. You were there truly to be the coach, so that I appreciated. I think having the same person is good because you're familiar with what's happened, and where we've been.
Changed my practice	8	It changed my whole teaching process. It's not like a specific strategy…You pushed me to think more about how to teach students math like a human being. It totally has changed, in my personal view, what I've been doing in my room.

		You coming in giving me feedback definitely affected my teaching. I will be a different teacher.
Getting specific feedback in the moment	7	I would say that coaching worked, because there are things that I do that I don't notice, having you in there, you would notice, and be able to give me feedback on.
Learned specific formative assessment strategies	7	Just little mini things like getting the entire class to raise their hand or put their thumbs up if they understand a concept, or thumbs down if they don't. I've come up with some new strategies and ideas and different tools to work with.
Having an external expert (math/ assessment person)	7	I can tell you for sure that if you had not been a math teacher I would have not wanted to do that. Because it seems like that's a specific type of teaching and if somebody doesn't have that background there really is no point. So I would've not even signed up. So that's how important that was. I also value your input because you came as an expert. So, that was a big difference. I have my own experience with my own class, over 20 years, and in different schools and different environments and different cultures, but then it is people like you that I think we need in class because it brings something else that we cannot.
Getting feedback over time	4	Coaching is nothing like you go to a one-day PD and you forgot next day, then you get busy. But this is a really meaningful thing to do, the continuous help is beneficial for me. I think that coaching is critical, because I think as you actually experience these things and discover new issues, then to revisit those ideas again is critical.
I am more reflective in my teaching	3	I'm more reflective about the kind of assessment that I'm going to have. Having someone come and give me feedback about my lesson gets me thinking internally about what things I'm doing well, and gives me more opportunities for me to incorporate more good things into my lesson.

Flexibility on part of coaches was appreciated	3	You were so flexible. My timetable, being part of the flexibility project, changes all the time, but that never was a problem. You always worked around that, so I would just say this is a really good model to follow.

Two additional individual comments with respect to the benefits of the model are worthy of mention. One teacher commented that having a coach in their school got dialogue within the mathematics department focused on teaching practices. Another noted that having an expert coach work with the teacher in her context was an efficient and cost effective way to provide direct support for teachers.

Challenges with the Coaching Model
In addition to the perceived benefits of the coaching model, some challenges were also noted. Most of the challenges were not explicitly stated by teachers, but rather implied through the conversations that took place between the teacher and the coach. The greatest challenge, as demonstrated by the length of time that it took the AAC facilitators to get initial contact with schools, was having schools and teachers initially agree to have the AAC coaches come to their school. Once schools and teachers had the AAC coach come to the school the first time, the momentum of having the AAC coach work with the teachers most often continued.

The second most challenging aspect of the model was organizational in nature: finding times where the AAC coach could come to the school to work with a specific teacher to either observe a lesson or to assist with planning. One teacher noted that

> Time is always the issue, and now in our school division next year we've built in some collaborative days where kids are not going to be at school and teachers are going to work with each other so that might open up some more of that time. Time's always the issue. But time to meet ahead, time for the actual classroom part to happen and then time to meet later, it just needs to be built in there somehow.

A second teacher commented, "We had to get this curriculum done, we had to get all our new lessons done, we had to get new exams made, we have to get all that stuff done," so the teacher did not feel like she accessed the services of the AAC coach as much as she could have. Though coordinating schedules and having time was noted as a challenge, teachers commented that the AAC facilitators were flexible in their schedules and their availability and flexibility was appreciated.

Other challenges that teachers noted related to the receptiveness of both the students and teachers to having somebody else in the classroom. One teacher noted, "It's almost like as soon as you ask for help or ask for some outside influence, some people feel like you're doing something wrong at the time." This teacher's comment might suggest that perhaps some teachers did not want to participate in the project because those teachers did not want to appear as though they were having difficulty.

Findings with Respect to Formative Assessment
The following section presents findings from the research study that are focused on formative assessment. The following topics are addressed: formative assessment strategies used, teachers'

understanding of formative assessment, benefits and challenges of integrating formative assessment including changes in teacher practice and perceived changes in student behaviour.

Formative Assessment Strategies

Throughout the project, a variety of formative assessment strategies were noted as either already being used by the teachers or were introduced by the AAC coach. What follows is an illustrated list of some of the formative assessment strategies that were evident in teachers' classrooms, along with accompanying descriptions of how the teachers used them.

> **Formative Assignments/Quizzes:** I gave what I call formative assignments, and instead of giving quizzes, which you'd mark and it would count for three percent or whatever, I gave a formative assignment. And then I'd give the assignments back to the students, and I still remember the first time I did, students looked at them and said what about the mark? I said there's no mark on here, I said the goal is that you have to get this whole thing correct and they said, oh, ok, and I said, so now I'm giving it back to you and I said I've made comments on there. I'm available and your friends are available whenever you get together and your textbook is available, your notes are available and they are all available for you to figure out what you did wrong, and to move forward and to make corrections.

> **Exit Slips:** When the lesson's done I'll take a question and say, I want you to do this one and when you've done it and have an answer bring it to me and if it's good then you'll be able to go and if it's not then you need to do some more work.

> **Observation:** I usually peruse the room, and go around as the students talk with each other. I talk with whoever's having trouble, and if there's a common question that everybody keeps asking me, then I might call them all together and go through that one question, but normally it's just me walking around one-on-one.

> **Learning Logs:** I asked students to tell me the easiest and hardest part of today's lesson. I then asked them to give me examples and non-examples of rational expressions.

> **Questioning Strategies:** What I'm going to ask is: What do you notice? What are you seeing between grid one and grid two? What's different about them?

> **Entrance Question/Slip:** Started the day with an entrance slip where I re-grouped the kids based on the entrance slip and moved them around to different places.

Not all of the strategies that teachers were using are described above; these are sample descriptions of how teachers were implementing some formative assessment strategies in their classes. Other strategies that were noted include using individual whiteboards to have students show their work, having students up at the large whiteboards working in groups on questions, using student response systems to do a formative review/quiz, and involving students in peer-review. The AAC coaches suggested potential strategies or refinements to strategies that teachers might explore in their classes, as well as pointed out strategies that teachers were already using that could be considered formative assessment.

Understanding of Formative Assessment

Teachers started in different places in regard to their understanding of formative assessment and with incorporating formative assessment into their lessons. Even if the teacher had a well-

defined sense of formative assessment, there was an indication of clarifying or expanding his/her repertoire of formative assessment strategies through participation in this project. Every teacher in the study either indicated a change in perception of what formative assessment is or indicated growth in being able to implement formative assessment strategies in the classroom. Below are samples of comments from teachers regarding their growth in understanding of formative assessment.

Beginning Understandings of Formative Assessment	Ending Understandings of Formative Assessment
For me formative assessment is something I have to record. That's what I used to think…so my AFL's[2] I used to think that it wasn't really AFL unless it was something recorded under my AFL in my marks program.	Formative assessment is a way for students to demonstrate their understanding of a particular topic, before being graded on it so students can assess for themselves and also for the teacher to assess whether the students are comfortable with the material; have they mastered it yet, or not.
I would say, formative assessment would be assessment that I do for learning, for the kids to know where they sit, for me to see where they're at, but it's not to be included for anything in their marks. That's what my understanding would be. If I had given them an exit slip and then looked at and gave them feedback but didn't put a grade on it, that's what I have in my head of what I could do for formative assessment.	I think it's broadened, I think there were things I was doing that were formative that I didn't really realize were formative before. Like I had come to believe that I'd have to be doing something for formative assessment, like an exit slip or there'd have to be something to show for it, but now I see that there's more things I could do in the structure of my lesson as I walk around and talk to kids that I'm doing it then, without it really being a piece of assessment and giving them information from observing and talking, where before I thought it had to be more of a piece of work, that I just didn't include the mark for.
Before I started formative assessment my attitude was always teach, test, hope for the best.	But now with formative assessment I can teach and test and know I should get their best so that's what I've changed for me.
We would always talk about formative assessment, but I don't know if we ever did really embed it well.	We use exit slips all the time. It's not that we'd never thought about doing it before. It's just like, until somebody actually puts it out there and says, we really probably should be knowing what these kids are doing before they write some kind of

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[2] AFL's refer to Assessments for Learning, another way to describe formative assessment.

	summative assessment. Doing homework and then checking, that's probably not always going to do it.
Formative assessment is not assigning a mark to it but giving them an idea of where they're at, in terms of learning, like along the process, if they're like halfway there, three quarters of the way there, a quarter of the way there. It helps not only for them to know where they are and what they need to study, but it definitely helps you with your next lessons too, because you can see what kind of things that they're having trouble with.	I think it added a few other things that I didn't really realize was formative assessment and it made me more conscious of little things, like getting students to come up on the board and write instead of me always up there doing all the answers, freeing me up more, letting me go around and help students that need more help, and then allowing them, the stronger students to kind of do the answers on the board etcetera, so just little things like that, so it definitely made me a better teacher.
So the point is all these things, including the self-checks, are getting you ready for the test.	Before, we'd call it formative because it tells you whether we're ready for the test, oh you failed, you're not ready for the test whereas now it's formative because now something has to change based on how you did.
You know we've had some ideas for how our formative assessment will look, and we've worked hard to build formative assessments that can be used in the future, at least one way of doing formative assessment. I remember when I first came out of university, we had talked about formative assessment, but I don't remember the emphasis being so strong on formative assessment as it is now. So, they'd tell you, it's good to get information kind of from students about where they're at, so that you can figure out what your next lesson is.	And I guess for me the biggest thing was, I need to get constant feedback where students are at, so that we know where we should go next, should we spend a little bit more time, should we move a little faster. So for me that was one of the big changes where it's always about hearing where the students are at in their learning and then adjusting your teaching to hopefully meet their needs.
So what do you think people are doing as far as formative versus summative evaluation? Especially when you get into the higher grades with math like what would be formative evaluation? So an exit card, would you put a question on it? Like	I would say that formative is a way of checking in with kids to see if they've understood what you've tried to teach them, and in a way that there's still time to work on those concepts if it hasn't gone as well as we all hope. Sometimes we

you don't just ask, are you ok? You might put something on it that says, what's this answer or work this out?	think we have taught them something, and but perhaps they haven't got it just as well as we wanted them to, and so it's a way of just checking in to get that feedback. And I should be clear, it's not related to marks or grades but to understanding.

Individual teacher determination regarding the type and frequency of their involvement with the AAC coaches resulted in variations in the way coaching with respect to formative assessment practices unfolded. Some of the teachers asked the coaches to observe lessons and provide feedback on the use of formative assessment strategies while other teachers took the opportunity to have formative assessment strategies modeled for them by the coach in their classroom. In both cases, conversations with the AAC coaches included explicitly identifying what, either in the observed lesson or in the modeled lesson, could be considered formative assessment. In many cases, the teacher would not have called what they were doing formative assessment until the coach identified it as such. One major finding from this research is that having a coach within a classroom specifically providing formative feedback on what formative assessment is and could look like in that classroom, improved teacher understanding of formative assessment.

Benefits of Formative Assessment on Teaching and Learning

Throughout their conversations with the AAC coaches and in the exit interviews, teachers commented on benefits they saw as a result of incorporating formative assessment practices in their classrooms. Themes within the benefits were noted during analysis. Those themes are identified in the table below, along with the number of teachers that made comments within that theme and illustrative comments from teachers. The benefits noted included both a focus on observed student behaviours as well as reflections on teacher practice.

Theme	# of teachers (out of 18)	Illustrative Comments
Provides immediate feedback to students about learning	8	I find that's very helpful to get that immediate feedback as opposed to, I'm going to take out a paper and I'll mark it two days from now and then I'm going to give it back to you three days from now and so next Tuesday I'll let you know how you did. By then we're writing an exam…by the time I mark an assignment and get it back to them we've done so much more that it's meaningless.

The good thing about these clickers is that at the end of the quiz the students immediately receive a percentage of how they did in this review and |

		they can see which of the questions they got wrong and that will guide them into how they can kind of assess where they need to go in the chapter to focus themselves for review.
Provides immediate feedback to teachers about learning	8	It was immediate feedback for them and it was immediate feedback for myself as a teacher. Because you're around with them that whole lesson, you know where they're struggling or not struggling rather than just leaving it to chance. I finally feel like I've accomplished something and they're learning something, and I heard all these different conversations and they were all about the project going on… it's just one of those moments where you think, ah, I am doing something.
Makes students accountable for learning	6	And that's something else out of these formative assessments I found is, I'm putting it back on your shoulders now. It's easy for me to mark it and give you a mark and say that you got seventy-five percent or say you got sixty percent, but my unit exams will do that for you. But for all this other stuff until we get to the unit exam you should be learning, you should be getting everything correct, and you should be excelling or striving to want to get everything correct, and to be learning everything. I put whiteboards, little whiteboards around my room and all their guesses were done in different colours of ink so I could tell who did what.
Easy to see where students are at	5	I'd mark the exit slips and it takes me about ten or fifteen minutes that evening, and I'd have a look at them and I'd come back the next day, and it was obvious that you did understand all of this and this is how we're now going to push forward today…I thought it was really, really cool. We started doing exit slips, and I'll be honest, I mean they work. We put them into three different categories - the category you're perfect, you know exactly what you're doing; if you make one tiny little error, we'll fix that really quickly;

		and then oops we have some work to do, and the next day it was easy enough to pull those kids aside and talk with them.
Opened up student communication about mathematics	3	I think some of them don't always understand the way I explain things, and so by opening that door and getting more comfortable about going to some of their other peers, they found other ways of explaining things…and they're more motivated and they're actually doing more math and less cell phones than they had been previously.

They're talking about math, they're talking about the whole process - what did you go through, and I did it this way, I did it that way and they are exchanging ideas. Oh it's great! |

Other benefits were noted in individual conversations that were not included in the themes above. One teacher commented that he saw a change in the way students treated their assessments. He said, "The biggest thing I noticed right away was the students aren't taking assessment backs and throwing them in their binder. They're taking assessments back and they're working at it." This teacher noted that when he gave feedback on assessments rather than a mark, students treated their assessments differently – they revisited them instead of disregarding the results.

One particular teacher, who was initially skeptical about the potential benefit of formative assessment, changed his views of formative assessment during this project. He tried allowing students to use a test that they wrote as a formative learning tool and then have the students write another version of the test. He wanted to see if students who performed poorly on the first test were able to improve their scores on the second test. What follows is an excerpt from his conversation with the AAC facilitator after the second test.

> Some of the kids that had failed made significant gains and that is why formative assessment has helped them because these are students that honestly have tried, they do study, they are not slackers but they just encountered difficulties…. So it gave these students an opportunity to *not* say, "Well I failed, I won't be good." They had an opportunity to be successful….
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> If you don't learn from your mistakes then you are just doomed to repeat them and that is why there are certain students at the very bottom that fail and they fail twice because they fail to learn from their errors and correct them and improve upon them. They just continue to make the same errors… If I just give the same test I pretty much expected the same results. But this time the fact that I didn't get the same results, especially from some of the lower achievers was, I thought, a significant gain… It wasn't that everybody went up 3% or 10%; some kids went up 60% to 70%. …their position on that test was significantly improved which wouldn't have happened without the formative assessment piece.

So this formative assessment gave some students a chance to say "I didn't think I could get this but now I can see where I went wrong and now I can get it." That breaks that cycle of negativity and then they start thinking a little bit of success can inspire them to say, "Hey, maybe I can do even better next time," whereas if you are always failing, "Oh what's the point," and then it becomes a self-fulfilling prophecy…

We all want students to be successful. We do, the parents certainly do and the student does. Even if he tries to pretend that, "Ah it's not important," it is important. They are just using that as a defense mechanism to explain why they did poorly. But they do care, they care they do poorly but they are so used to failing that they slough it off. "Ah it's not important." But really they know it is important and they know school is important, especially at the high school level. So if we can get them into a state of mind of where they think, "I can do it, then I can do something important for myself," that is great.

This particular teacher made significant connections between formative assessment and the potential benefits for student learning through participation in this project. He also commented that he is going to integrate formative 'tests' from the beginning of his courses next year.

Other benefits were noted, including having less marking, being able to help those students who are withdrawn and don't speak up in class, and providing opportunities for students to have mathematical conversations that would likely not have occurred otherwise. Every teacher in the study noted a benefit, a change in student learning, a change in student behaviour, or a change in his or her teaching as a result of participating in the coaching model of PD. One teacher summed up by saying, "I believe the formative assessment is great work; it's beautiful work - what it can do for students."

Challenges of Implementing Formative Assessment
Though benefits of formative assessment were prominent in the conversations, integrating formative assessment into practice also presented some challenges. Five teachers noted that there was resistance on the part of the students to fully participate in some of the formative assessment activities. They also noted that once students saw the value in the activity, or the activity became part of classroom routine, there was less resistance. One teacher's comments in regard to students resisting having conversations and learning from each other was that "they've still been really, really trained to learn from the teacher and it's going to take some time." Specifically with respect to implementing self-assessment, a teacher commented that some students do not necessarily accurately assess their abilities; they are either too hard or too easy on themselves. Another teacher commented that implementing some of these ideas part way through the semester was not helpful, but he would be sure to incorporate many of the strategies for the beginning of the next semester. Four teachers noted it was important to keep a balance in regard to accommodating those students who prefer working on their own and writing notes down neatly, as well as those students who prefer to have conversations about mathematics and learn from each other. A variety of formative assessment strategies that allow each student to be able to express his or her understanding was noted as being essential to effective formative assessment.

Teachers also noted challenges for themselves when trying to integrate formative assessment into their practice. Teachers found that time to prepare or to think up formative assessment

activities was a challenge. A beginning teacher noted, "A lot of times it's just tough to physically set up the groups and the stations. I think it's something you can build over years with activities, but it's tough." Three teachers also noted a time constraint and that incorporating some of the formative assessment strategies might take too long and that they "feel the time crunch" with the curriculum. Two teachers commented that they were not completely comfortable with the strategy they were discussing with the AAC coach and did not want to try it if it was not going to be successful. "I feel my first go has to be a successful go," one teacher said. Even when teachers noted benefits from integrating formative assessment activities, there were still challenges to overcome to embed new strategies into the teacher's practice.

Conclusions

Findings Summary
From the data collected during interactions between the AAC coaches and participating teachers, as well as from the exit interviews, the following conclusions can be made.

- The coaching model of professional development was successful in providing project teachers with immediate and relevant feedback in regard to integrating formative assessment practices into their teaching.
- Sustained coaching by subject and assessment experts allowed project teachers to make enhancements to their teaching practice.
- Flexibility on the part of the coach was essential to meet the dynamic needs of teachers.
- Project teachers' understanding of what constitutes formative assessment was enhanced through sustained coaching focused on formative assessment.
- Integrating formative assessment was seen by the project teachers as having benefitted student learning and behaviour.
- Challenges to implementing formative assessment strategies were multi-layered and depended on the specific context of the project teachers.

Limitations of Research Study
Three limitations to the current study are described below.

1. The grant provision specifying a population from which to recruit participants for the research provided some challenges in regard to the research design. The sample for this research study included a small, not necessarily representative, sample of high school mathematics teachers in Alberta. Though the teachers in this study were a mix of male and female, beginning and experienced, rural and urban, there was no selection process that allowed for a larger variation of teaching contexts.

2. A second limitation of the study is that teachers participating in the project received varying amounts of coaching depending on when the teacher agreed to participate as well as the teacher's ongoing availability and interest. As the PD model selected for this study is based on the principle of being responsive to teacher needs, making generalizations with respect to the type of support, number of visits, and time spent in coaching is not appropriate.

3. A third limitation is that the benefit of formative assessment with respect to student achievement could not be concretely determined. This limitation was due in part to time constraints with the length of the study, as well as the length of time required to determine

teacher participation. These time constraints resulted in an inadequate time frame in which to obtain ethics permissions from students as well as appropriate student data.

Recommendations

The following are the researcher's recommendations for further study based on the findings and limitations of the current study:

- Sustained coaching by experts in subject matter and in the field of assessment should be further explored as a viable professional development model.
- A larger study that incorporates a representative sample of teachers across the province and takes place over at least two school years is needed to show effects of the sustained coaching model of PD over time with respect to teacher practice and student achievement between grades.
- Lasting impact of different professional development models should be explored and compared to determine which model is most effective for enhancement of teacher practice.