Design Case for Asynchronous Online Professional Development in Primary Grades Mathematics

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Introduction

This design case shares the process of designing, implementing, and modifying asynchronous online mathematics professional development for elementary school teachers. Based on the recommendations of Boling (2010), we provide a rich description of the design decisions, experiences, and learning outcomes from our project. Further, informed by Smith (2010), this design case includes both typical sampling and critical case sampling. Specifically, we included typical design elements while also attempting to highlight aspects of the case that were very influential on the design and outcomes, such as the video excerpts of students that teachers had to analyze. This design case includes both data triangulation by examining artifacts from the designed professional development, teachers' work samples, and data that we collected during the project (Smith, 2010).

We begin by describing the overall context—a large grant-funded project focused on enhancing elementary teachers' skills and knowledge related to teaching mathematics. We then describe our design process, followed by examples and descriptions of the asynchronous professional development modules we designed. We close with a reflection on distinctive aspects of our design case.

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Context

Purpose of the Design We designed online teacher professional development modules as part of a larger project funded by the North Carolina Department of Education Mathematics and Science Partnership grant program. The professional development experiences focused on supporting teachers' knowledge and skills related to using the Internet-based assessment tool *AMC Anywhere* (Math Perspectives, n.d.). The goals of the project were to support elementary school teachers to develop:

1. Knowledge of how young learners develop number sense skills.
2. Knowledge of mathematics related to number sense.
3. Skills and knowledge related to using the Internet-based formative assessment mathematics program *AMC Anywhere*.
4. Skills and knowledge related to using data from *AMC Anywhere* to plan mathematics instruction.

AMC Anywhere includes nine assessments intended to give teachers formative information about their students' understanding of number sense, which they can then use as they plan and implement targeted instruction with provided instructional materials (Didax, 2012). These assessments align to mathematics standards typically found between kindergarten and second grade. Teachers conduct the assessment one-on-one with each student. The assessment takes only a few minutes to complete. In some cases, teachers provide hands-on objects such as mathematics manipulatives for students to use in certain parts and then take them away to advance to a higher level of difficulty.

Figure 1 is a screenshot from the *Hiding Assessment*, which requires students to solve tasks related to addition and subtraction. In the task below, teachers ask students to identify numbers that can be added together to make a total of eight.

Like most Internet-based assessment tools, *AMC Anywhere* stores data and allows teachers to retrieve data per individual student or by class. School administrators and district leaders can access and organize data by grade, schools, or even entire school districts. Data from the progress report connects to related instructional materials, allowing teachers to have a direct course of action to provide instruction based on data.

Figure 2 is a sample student progress report, which allows teachers and others to view students' growth over time. The numbers listed in the top data row identify the number the student was finding addition combinations to; for example, 6 means that students were told that there were total of 6 counters, but only 4 were visible. They were then asked to determine how many counters were hiding. The ratings are given by the letters in the table: A means ready to apply, P means more practice is recommended, I means that explicit instruction is needed, and N means that the student is not ready for any work related to that number.

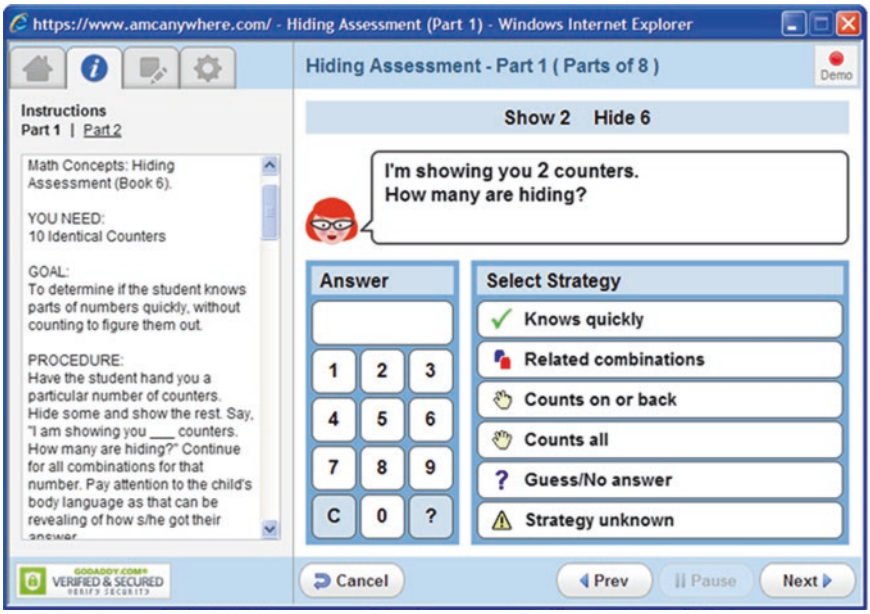

Fig. 1 Screenshot of *AMC Anywhere* Hiding Assessment

Critical Decisions in Our Design Process of the Professional Learning Experience

The professional development experiences, including face-to-face workshops and online experiences, were designed and implemented with 250 primary grade teachers in five school districts across North Carolina over a 3-year period. All participating teachers were using the same North Carolina mathematics standards, and all districts were using similar curricular resources that aligned with student-centered pedagogies. Teachers were recruited by district leaders, but all of them volunteered to participate in the project. In turn for participating, teachers received a stipend for summer work and the online modules, access to the online formative assessment tool for the duration of the grant, and a full set of instructional materials that aligned to the formative assessment tool.

During the summer, all teachers started their project work by participating in 40 hours of a summer workshop focused on using an Internet-based formative assessment mathematics program that they accessed via either a laptop computer or iPad. The workshops were district-specific, but teachers from different school buildings within a district worked together during the workshops.

The grant's guidelines required at least 40 hours of face-to-face workshops with teachers during the summer, but was open to how teachers completed 20 hours of professional learning experiences during the year. Based on our knowledge of teachers' busy schedules during the school year, we knew scheduling face-to-face

Hiding Assessment - Part 1: Identifies Missing Parts of Numbers with Models								
Date	3	4	5	6	7	8	9	10
10/11/2013		A	P	I				
02/20/2014		A	P+	P				
05/22/2014			A	I				

Hiding Assessment - Part 2: Identifies Missing Parts of Numbers without Models							
Date	4	5	6	7	8	9	10
10/11/2013	N						
02/20/2014	P	P					
05/22/2014	P+	P	A	P	P	P	P

Fig. 2 Student progress report from *AMC Anywhere*

workshops would be challenging. The project management team included project staff and district leaders, who were knowledgeable about the school contexts. We considered various possible options, including evening and weekend face-to-face workshops, synchronous online professional development, and asynchronous professional development.

The project included six different school districts across the state, all with different school contexts. Therefore, the project staff, which consisted of mathematics educators and graduate students, and district leaders reached consensus and decided that synchronous professional development activities—whether online or face-to-face—would not be as effective compared to asynchronous modules, which could be completed when teachers were ready to complete them with support from district leaders. One of our previous projects and other statewide efforts showed poor attendance in evening workshops, and school districts in this project were not willing to have teachers come to professional development during the school day, even if substitute teachers were paid for by the grant.

During the initial planning stages, project staff from three of the smaller school districts requested that professional development materials and modules be built so that teachers could complete them online or in person workshops being led by district leaders. The larger districts, however, wanted online materials only, since they logistically could not determine how to bring all of the teachers together to the same

space. Further, the initial planning stage included the creator of the assessment tool, who was not familiar with anyone who had done online professional development related to the tool. As a result, there was some tension and uncertainty around whether or not online professional development during the year would be effective.

We framed modules around principles of effective professional development (Polly & Hannafin, 2010) and included classroom-based, job-embedded professional learning activities that teachers completed. After completing these activities, they submitted artifacts including written reflection as evidence of their work and learning. To this end, we opted to design asynchronous online professional development for all of the teachers. As a result, one of the next design decisions we faced was determining how to structure online professional development resources for the teachers. Since some teachers taught together in the same school or district, some teachers met together with other teachers and worked together in the same room on these activities. The three smaller districts made arrangements for teachers to come together to the district's central office to complete most aspects of the online modules together at the same time.

We conducted a needs analysis after the summer workshops to identify focal content. District leaders participated in a planning meeting where they stated their perceived needs for teachers who worked in their district. We also asked teachers on the last day of the face-to-face workshops to provide their opinion about concepts they wanted to learn more about. We found alignment between district leaders' and teachers' desires to participate in more professional learning activities focused on three areas: (1) structuring and organizing their classroom to collect formative assessment data; (2) analyzing formative assessment data after collected to identify students' needs; and (3) aligning the state mathematics standards, their mathematics curricular resources, and the formative assessment program. In year one of the project, the project leadership team, which included university faculty such as myself and district leaders, decided to design learning experiences that addressed all three of those needs. We designed the work to occur across the entire year.

In considering how to support teacher learning in the absence of synchronous meetings, we wanted learning experiences that would connect what they had learned in the summer workshop, focused on how to use the assessment tool, how to analyze data, and how to make instructional plans. We also were committed to a structure that created opportunities for teachers to dialogue with each other.

Since project staff and district leaders decided that the optimal format was for teachers to complete the professional learning experiences in an asynchronous manner, we saw a need to be explicit about the steps and processes related to analyzing the data they would collect using the *AMC Anywhere* tool. We elected to include video-based cases in the online modules. This process of watching a video and using the program to assess the student's performance is an experience teachers had completed five times during the summer professional development. By including the task of watching videos and assessing students who were in the video, we provided teachers with the opportunity to review what they learned during the summer and helped teachers refresh how to use the program before using it to assess their students' progress. We therefore also provided access to the video cases. As project

staff and district leaders collaboratively planned the activities, they felt that teachers needed a heavily scaffolded and detailed template to help them with data analysis and creating instructional plans.

Lastly, when considering how to write and frame opportunities for teachers to reflect on their experiences, their teaching, and student learning, project staff and district leaders reached consensus that the reflections should focus on student learning instead of on teacher performance or teacher actions. This approach, all stakeholders felt, mitigated the potential that teachers would get defensive about their use of specific instructional strategies or curriculum resources. We also hoped it would focus teachers' work on students' growth in understanding of mathematics and attention on what they were noticing about their students while they were teaching.

Description of the Professional Development

The 20 hours of online experiences were divided into three modules, which were housed in a learning management system operated by the North Carolina Department of Education. Each module included a series of tasks (Table 1) that aligned to research-based, learner-centered approaches to teacher professional development (Garet, Porter, Desimone, Briman, & Yoon, 2001; Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2009; Polly & Hannafin, 2010).

Table 1 Tasks in modules

Module	Time of year	Professional learning activities
Module 1	September–October	Solving mathematical tasks Watching videos and practicing analyzing students' mathematical understanding Assessing the whole class using the Internet-based formative assessment program Writing about assessment results, setting up classroom
Module 2	January–February	Solving mathematical tasks Watching videos and practicing analyzing students' mathematical understanding Assessing the whole class using the Internet-based formative assessment program Writing about assessment results Developing a differentiated instructional plan for a group of students based on data
Module 3	April–May	Solving mathematical tasks Watching videos and practicing analyzing students' mathematical understanding Assessing the whole class using the Internet-based formative assessment program Writing about assessment results Watching videos and read about number talks activities, try to do a number talk with students

We included three common tasks in each of the three modules: (1) video-based cases of students being assessed for teachers to watch and analyze, (2) scaffolded activities to support teachers' analysis of their students' data, and (3) opportunities for teachers to write about and reflect about their students' performance based on data they had collected. All of these focused on authentic classroom-based work and students' performance, which were primary goals of the project.

Video-Based Cases Each online module included video-based cases of students completing the same assessments that teachers were expected to administer to their own students. These cases scaffolded teachers to read a short two-page article about the content, to watch the video of students doing the mathematics assessment, and then to respond in writing to the video about students' performance. For instance, in Module 1, teachers first reread material from the summer workshop about strategies that children use to count a set of objects. They then watched two videos of two children counting a set of objects and used the *AMC Anywhere* online assessment program to assess students during the video. Figure 3 shows a screen capture of the video and prompts that teachers were expected to respond to.

Teachers wrote their responses in a threaded discussion so that they could interact and dialogue with each other about their observations and thoughts about the video. As teachers wrote their responses, design team members and graduate students facilitated the online discussion posts by responding to teachers and posing additional questions to continue the conversation. We found that while we designed the online threaded discussion to be a forum for ongoing dialogue, most teachers just posted the one required time. Even when we asked a follow-up question on the discussion forum no one responded.

Scaffolded Activities to Support Data Analysis We also incorporated tasks in each module to support teachers' effort to analyze their students' performance using data collected with the online *AMC Anywhere* program. These tasks, while similar to teachers' work during the face-to-face workshops, had a higher degree of authenticity since they were using the program to assess their own students in their class. Across the three modules, we focused on various skills related to data analysis and instructional planning including collecting data using *AMC Anywhere* (Modules 1, 2, and 3), printing reports of student progress (Modules 2 and 3), analyzing reports to look at trends in the data over time (Module 3), identifying instructional activities

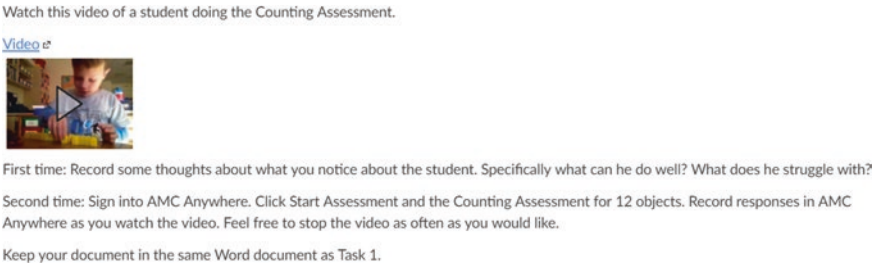

Fig. 3 Screenshot of video-based case from professional development

that meet the needs of specific students (Modules 2 and 3), and making a plan about how to implement those instructional activities (Module 2).

For instance, in Module 2, teachers collected data in the second task using a template designed by project staff to create an instructional plan based on their data. The template included sections for teachers to enter the students they were focused on, their data, a summary of their interpretation of the data, and a list of next instructional steps to meet the needs of their learners. Finally, teachers wrote a reflection of how the implementation of their instructional plan went after 3 weeks of use.

Written Reflections About Students' Performance and Instructional Decisions In each module, teachers reflected in writing about students' performance and data they collected and analyzed. In addition to focusing on student outcomes, the written reflections focused heavily on next steps and the "so what" aspects of teaching. For example, after teachers analyzed data for their entire class, one prompt was, "Based on what you know about your students, identify a small group of students who have the same need and could benefit from the same types of activities."

Reflections on Distinctive Aspects of the Design and Plans for Future Design Work

While the design of online mathematics professional development modules led to gains in primary students' achievement (Polly et al., 2015; Polly et al., 2017) as well as teachers' adoption of specific instructional practices (Polly et al., 2017; Polly, Martin, Wang, Lambert, & Pugalee, 2016), some teachers struggled or were resistant to implementing the formative assessment mathematics practices emphasized in the project. These teachers had less of an impact on their students' achievement (Polly et al., 2015, 2017). These insights suggest necessary changes for our design of future professional learning opportunities for teachers.

Specifically, we feel that based on the data, future designs of online asynchronous professional development activities need more rich ways to support teachers' work in their schools to ensure more of a carryover from the activities into their own classrooms. It was challenging to make sure that teachers felt supported and were likely to apply what they learned from the summer face-to-face workshops and the online asynchronous modules into their classroom on a consistent basis. We know from our project that teachers from the smaller school districts received face-to-face support from a district or school-based leader for each module. In some cases, teachers brought their devices to a common location and completed parts of them with each other to have just-in-time help and support while they were working. From data, the presence of face-to-face support seemed to have increased the likelihood that teachers implemented the formative assessment practices with fidelity. Based on this, in the future, we would think of ways to bring the elements of face-to-face support that led to fidelity into the online professional development experi-

ence. For instance, we could provide teachers with the options of online synchronous sessions or video chats with a facilitator.

In terms of the design process, this project was interesting to us and we believe successful since it included the buy-in and input from project leaders who were university faculty in mathematics education, some of which have a background in designing online learning, school-based mathematics leaders, as well as input from the developers of the online formative assessment tool that was the focus of this project. Further, we gathered input regularly, from the initial needs analysis to participants' reflections and responses about the project in order to ensure we were meeting their needs as best we could. At the end of the day, we learned that designing online professional development for multiple districts working with a diverse set of context-specific factors was challenging, and in some cases the fidelity of implementation and impact on teachers' and students' learning varied. Nonetheless, we feel that providing a learner-centered set of opportunities that tried to meet some of their specific needs led to a better designed experience than something that was more generic, only focused on the formative assessment tool and not the needs of teachers or learners.

References

Boling, E. (2010). The need for design cases: Disseminating design knowledge. *International Journal of Designs for Learning, 1*(1). Retrieved from: https://scholarworks.iu.edu/journals/index.php/ijdl/article/view/919/978

Didax (2012). *AMC anywhere*. Retrieved from: https://www.didax.com/amc-anywhere

Garet, M., Porter, A., Desimone, L., Briman, B., & Yoon, K. (2001). What makes professional development effective? Analysis of a national sample of teachers. *American Educational Research Journal, 38*(4), 915–945.

Loucks-Horsley, S., Love, N., Stiles, K. E., Mundry, S., & Hewson, P. W. (2009). *Designing professional development for teachers of science and mathematics* (3rd ed.). Thousand Oaks: Corwin Press.

Math Perspectives (n.d.). *AMC anywhere*. Retrieved from: http://assessingmathconcepts.com/

Polly, D., & Hannafin, M. J. (2010). Reexamining technology's role in learner-centered professional development. *Educational Technology Research and Development, 58*(5), 557–571. https://doi.org/10.1007/s11423-009-9146-5

Polly, D., Martin, C. S., Wang, C., Lambert, R. G., & Pugalee, D. K. (2016). Primary grades teachers' instructional decisions during online mathematics professional development activities. *Early Childhood Education Journal., 44*(3), 275–287. https://doi.org/10.1007/s10643-015-0711-8

Polly, D., McGee, J. R., Wang, C., Martin, C., Lambert, R., & Pugalee, D. K. (2015). Linking professional development, teacher outcomes, and student achievement: The case of a learner-centered mathematics program for elementary school teachers. *International Journal of Educational Research, 72*, 26–37.

Polly, D., Wang, C., Martin, C. S., Lambert, R. G., Pugalee, D. K., & Middleton, C. W. (2017). The influence of an internet-based formative assessment tool on primary grades students' number sense achievement. *School Science and Mathematics, 117*(3–4), 127–136. https://doi.org/10.1111/ssm.12214

Smith, K. M. (2010). Producing the rigorous design case. *International Journal of Designs for Learning, 1*(1). Retrieved from: https://scholarworks.iu.edu/journals/index.php/ijdl/article/view/917/980