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Joseph, Nicole M.; Leonard, Jacqueline; Viesca, Kara; and Hamilton, Boni, "Mathematics Teachers' Perspectives on Online Professional Development Modules" (2015). *Faculty Publications: Department of Teaching, Learning and Teacher Education*. 218.
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From: NABE Journal of Research and Practice, vol 6 (2015)

<https://www2.nau.edu/nabej-p/ojs/index.php/njrp/article/view/95>

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NABE Journal of Research and Practice is a publication of the National Association for Bilingual Education in association with the Northern Arizona University College of Education. For more information, visit About the journal.

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Abstract

This study examines mathematics teachers' perspectives regarding newly developed online professional learning for elementary mathematics teachers of multilingual learners. We examined the responses of 12 teachers on surveys that included both Likert scale and open response items to explore the learning, strengths and weaknesses of the modules. Overall, this study demonstrates the potential for online professional learning at the intersection of language and mathematics and suggests important ways for teacher learning across time to be supported.

Keywords: mathematics teachers, online, professional development

Mathematics Teachers' Perspectives on Online Professional Development Modules

Having been on the receiving and delivery end of professional development, it is apparent that the traditional teacher workshop, which is usually a single isolated event, is less than ideal to bring about changes in classroom practice (Borko, 2004; Dana, Dawson, Wolkenhauer, & Krell, 2013; McConnell, Parker, Eberhardt, Koehler, & Lundeberg, 2013). Teachers usually enter these *event-based* workshops with coffee and newspaper in hand, stoic faces, and a silent glare that says: *"I dare you to make me participate today!"* Yet, in the best of these types of settings, teachers do end up participating if a variety of interactive multimedia and resources (i.e., handouts, articles, and books) are available, and an upbeat, energetic, and knowledgeable facilitator conducts the workshop. The camaraderie and trust that are built in these settings discourage freeloading (i.e., letting others do all the work) and ensure that collaboration occurs (Matzat, 2013; McConnell et al., 2013). However, what cannot be determined is whether new learning has occurred or if teaching improves as a result of these traditional workshops.

Given the technological advances of the past decade in terms of videoconferencing (i.e., Skype™, WebEx™, Adobe Connect™, etc.), courseware (i.e., Elluminate™ and Wimba™ via Blackboard), and authoring tools (Authorware™ and Haiku™) teachers can take advantage of online professional development just as easily as students in higher education have taken advantage of online learning (Leonard & Guha, 2001; Dana et al., 2013; Dede, 2006; Dede, Ketelhut, Whitehouse, Breit, & McCloskey, 2009; Matzat, 2013). Online professional development remediates "fragmented, intellectually superficial" workshops that do little to improve teaching and learning outcomes (Borko, 2004, p. 4). However, what face-to-face professional development offers in terms of building trust and camaraderie can be obtained in online learning communities (OLCs), particularly when teachers engage in action research to test

theories and reflect upon their practice (Brooks, 2010; Dana et al., 2013; McConnell et al., 2013). It is within the context of OLCs that a team of researchers received funding from the U.S. Department of Education to develop online professional development modules to prepare urban teachers to provide linguistically responsive (Lucas, Villegas, & Freedson-Gonzales, 2008; Lucas & Villegas, 2011) instruction to improve multilingual learners' acquisition of language, literacy, and content knowledge in mathematics and science.

The e-Learning Communities for Academic Language Learning in Mathematics and Science (eCALLMS) program (a National Professional Development project funded by the Office of English Language Acquisition¹) aims to link academic language development in mathematics and science to World-Class Instructional Design (WiDA) and Center on Research on Education, Diversity, and Excellence (CREDE) Standards to ensure that modules align with effective practices for multilingual learners and effective pedagogy. Program goals include the development of 27 modules—nine each in second language acquisition, academic language in mathematics, and academic language in science. The purpose of this paper is to examine the content and pedagogical strategies embedded in a module developed on fractions to improve teachers' knowledge and use of academic language in elementary mathematics classrooms. Specifically, we asked and answered the following research questions:

- What are mathematics teachers' perceptions of an online professional development module focused on fractions?
- How do mathematics teachers perceive the value of the fractions module?

We situate this project by presenting a brief description of the online professional development under discussion, then a review of the extant literature, followed by the theoretical framework

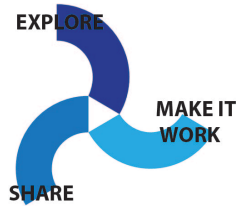
¹ PR/Award Number: T365Z110177-12

and methods we employed. We discuss our findings and end with conclusions and implications.

eCALLMS Online Professional Development Modules

eCALLMS modules are unique multimedia resources for professional learning communities of teachers to be supported in improving their practice working with multilingual students. Designed by interdisciplinary teams of faculty (particularly STEM educators, second language acquisition faculty, and instructional technology experts), eCALLMS modules strive to support linguistically responsive teaching (Lucas & Villegas, 2011). For example, within the module under investigation in this study, teachers deepen their own understanding regarding the mathematical concepts surrounding fractions, while at the same time they investigate the particular language demands present in teaching those concepts. Teachers learn to scaffold and support students in meeting the language demands of the particular content area under investigation. eCALLMS modules strive to help teachers meaningfully teach both grade level content and the academic language associated with that content.

Each module is intended to last six weeks and requires approximately two hours of teacher's time online each week. Within an eCALLMS module, teachers engage in the same cycle of learning each week. First, they "Explore" new ideas and concepts, then they put their learning into practice in their classroom with "Make it Work" activities. Finally they return online to "Share" what they did, new insights, questions, successes, concerns, etc. with their module colleagues. The following graphic illustrates this basic design element and fundamental structure of eCALLMS modules.



Another unique feature of eCALLMS modules is that they are un-facilitated and therefore, not traditional in terms of a course or professional development. Rather, eCALLMS modules are intended to be high quality, dynamic, interactive resources to guide and support professional learning communities in collaborative, engaged, and situated learning. However, as the project moves forward and more districts are utilizing these resources, some in-district facilitation options are being explored, mostly for accountability and support purposes. Yet, eCALLMS modules, particularly the one under examination in this study, were developed to be un-facilitated learning experiences grounded in practice and collegial online collaboration. To learn more about eCALLMS modules, please visit <http://ecallms.ucdsehd.net/>.

Literature Review

Three bodies of literature contribute to our work regarding online professional development modules to improve academic language learning in mathematics among multilingual learners: (1) linguistically responsive pedagogy; (2) teachers' beliefs about academic language development and multilingual learners; and (3) online professional development communities. The eCALLMS modules help to promote the national vision of world-class education for all *children* in the U.S., especially Latina/o and African American children, who by and large attend schools in urban school districts.

Linguistically Responsive Pedagogy

Changing perceptions and educational approaches to enhance the learning of linguistically and culturally diverse populations is an ongoing challenge, both politically and educationally in

the U.S. (Lucas, Villegas, & Freedson-Gonzalez, 2008; Nevarez-La Torre, Sanford-DeShields, Soundy, Leonard, & Woyshner, 2008; Nieto, 2002). For quite some time (as is well documented), multilingual learners have been the fastest growing demographic group in U.S. schools (Bunch, 2013; Hakuta, 2011). Nevertheless, research suggests that elementary teachers are ill prepared to provide opportunities for multilingual students to acquire academic language, especially in high status courses like mathematics and science (Lucas et al., 2008; Nevarez-La Torre et al., 2008; Silva, Weinburgh, Malloy, Smith, & Marshall, 2012).

In the design of our mathematics and science modules, we have been careful to embed research driven practices and strategies into online professional development opportunities. For example, Solano-Flores and Trumbull (2003) contend the “complex nature of language, including its interrelationship with culture” is often overlooked in current research and assessment paradigms (p. 3). This disconnect is also true in terms of content delivery and instruction in the nation’s classrooms. Lucas, Villegas, and Freedson-Gonzalez purport (2008) that “language learning and academic learning cannot be disentangled” (p. 363). Therefore, some contend that teacher education programs should be redesigned with courses that can support teacher candidates’ development and expertise in second language acquisition, bilingualism and biliteracy, and linguistically and culturally responsive pedagogy (Lucas et al., 2008; Nevarez-La Torre et al., 2008). Strategies that support the development of such expertise include scaffolding to provide a context for language development (Lucas et al., 2008; Silva et al., 2012). Scaffolding is one way to map Vygotsky’s (1978) zone of proximal development to academic language learning in mathematics (Albert, 2000; Lucas et al., 2008).

Attending to the vocabulary associated with learning mathematics content can help early childhood and elementary students develop a mathematics register to learn academic language

(Moschkovich, 2002). Even early childhood students who are fluent in English have difficulty understanding order, sequencing, and place value in mathematics. While *third* can imply the number three and *fourth* the number four, what does the word *first* have to do with one and *second* with two? The counting sequence makes sense (i.e., one, two, three....) until you say eleven and twelve. *Oneteen* and *twoteen* have meaning and fit nicely with *thirteen* and *fourteen*. In terms of place value, there are ones, tens, and hundreds, but where are the *oneths* when students learn about tenths and hundredths? Why not call a half *twoths* since there are thirds and fourths (Ball, 1993)? Helping multilingual learners to acquire academic language requires teachers to utilize scaffolding strategies such as the 5-R model suggested by Silva et al. (2013): replace (use familiar language); reveal (focus on distinct vocabulary); reposition (shift from social discourse to academic discourse); repeat (practice saying new words); and reload (discuss words within context). Additionally, sequencing words like *next* and *after* (Tan, 2011) and adjectives like *only* and adverbs like *always* (Solano-Flores & Trumbell, 2003) are frequently used in mathematics and can be a source of confusion for multilingual learners. Thus, we provide opportunities to learn vocabulary and context cues in the design of the eCALLMS modules.

Teacher Beliefs and Language Content Learning

There is a plethora of research on teacher beliefs in mathematics education (Charalambous, Panaoura, & Philippou, 2009; Evans, Leonard, Krier, & Ryan, 2013; Newton, Leonard, Evans, & Eastburn, 2012; Swars, Hart, Smith, Smith, & Tolar, 2007). Teacher beliefs are an important factor in the discourse on highly-qualified teachers and reform-based teacher practices (Evans et al., 2013; Newton et al., 2012). However, very little of this research has focused on teacher beliefs as it relates to teaching language in mathematics classrooms

(Moschkovich, 2007; Tan, 2011). Changes in classroom routines and incorporating different pedagogical strategies, such as the development of academic language among multilingual students, require a shift in teacher behavior. Learning to implement instruction around mathematics or science discourse mandates developing new modes of interaction in classroom settings (Tan, 2011). Teacher practices are difficult to change without also changing the beliefs that are associated with that change (Pajares, 1992). An individual's beliefs may endure even when they are discredited by reason, evidence, or experience (Pajares, 1992). Thus, it is important for teachers to confront their beliefs and biases about multilingual learners in order to change their practices.

Tan (2011) conducted a study that examined secondary mathematics and science teachers' beliefs about implementing language instruction in Malaysia. What is interesting about this study is a new policy was instituted that required teachers in Malaysia to switch their instruction from the national language, Bahasa Malaysia, to English in all content areas. Mathematics and science teachers were paired with English teachers to provide assistance during the transition. The primary data source for the study was teacher interviews, which were analyzed using open and axial coding to find themes and sub-themes, respectively. Tan (2011) used the constant comparative method described by Lincoln & Guba, (1985) to compare and contrast teachers' responses across the themes and sub-themes. While teachers saw themselves "first and foremost as subject matter teachers" (Tan, 2011, p. 331), there were differences among mathematics and science teachers that are relevant to the development of eCALLMS modules. Tan (2011) found that teacher beliefs determined the content and pedagogy observed in mathematics and science classrooms. Science teachers had nuanced beliefs about the interplay between language and content whereas mathematics teachers believed that students became proficient in mathematics

by *doing* mathematics (i.e., practice and problem solving). Science teachers demonstrated effort to infuse linguistic elements into their pedagogy while mathematics teachers did little to promote linguistic development, claiming such activities took too much time and slowed the lessons down. Science teachers were willing to model the use of academic language and encouraged their students to use English in science classes, but these same “students were not given the opportunity to master mathematics discourse” (Tan, 2011, p. 336).

Such pedagogical decisions are not simply the result of beliefs about students but beliefs about mathematics itself as a subject domain and the nature of mathematics; that is, what mathematics is and how it should be taught (Evans et al., 2013). Rigid views about mathematics content influence teachers' behavior. In order to teach mathematics effectively to diverse learners, teachers must move from viewing mathematics exclusively as practice and problem solving to understanding mathematics as a language that has meaning and cultural purposes (Leonard, 2008; Moschkovich, 2002). For this reason, language development, culture, and meaningful scaffolds are embedded in the design features of the eCALLMS modules.

Online Professional Development Communities

Research on professional development models suggests that event-based, one-time workshops are ineffective and do not lead to changes in teacher practice (Borko, 2004; Dana et al., 2013; McConnell et al., 2013). Given limited time and budget constraints, virtual models are transforming the delivery of traditional, face-to-face (FTF) professional development. Rather than accruing the costs of substitute teachers, travel, and related expenses, districts can use their resources to support asynchronous text-based platforms (i.e., Haiku, Second Life, and Twitter) to help teachers learn new practices and techniques (Davis, Merchant, & Kulm, 2013; Matzat, 2013; McConnell, 2013). If coupled with professional learning communities (PCLs), virtual

professional development can become a powerful tool to promote teacher change (McConnell et al., 2013). PLCs emphasize three main ideas: (1) learning; (2) collaboration; and (3) results (McConnell et al., 2013). Learning is dependent upon the success of the PLC, which can be FTF or online. Online learning communities (OLCs) are usually much larger than FTF PLCs and do not have to convene at a mutual time and place (Matzat, 2013). Rather, OLCs depend on the “voluntary engagement of their members to share their knowledge and experiences” (Matzat, 2013, p. 40). Therefore, it can be challenging to truly create online communities (Baek & Barab, 2005; Barab, MaKinster, & Scheckler, 2004).

One challenge rests in how active members of the OLC are in their posts and responses to their colleagues. Research suggests that when participants receive little to no feedback on their posts they will often stop posting (Keown, 2009). Also, Lowes, Lin and Wang (2007) found that when posts contain only cheerleading, there is a low possibility that an online discussion would continue. In contrast, in Lowes, Lin and Wang's study, when posts provided new information or posed questions or challenges, the overall thread had a 51% likelihood of continuing. Similarly, Prestridge (2010) found higher levels of discussion in online learning when teachers shared experiences, new ideas and raised questions. Hull and Saxon (2009) also found that questions provoked deeper responses in online discussions in OLCs. The eCALLMS module design team has benefited from the results of this research regarding online engagement as it has informed our development of both up-front training to eCALLMS module participants regarding effective engagement within the OLC as well as provocative and discussion-promoting questions within each module.

A study by Dana et al. (2013) revealed a positive impact for teachers participating in an OLC while they engaged in action research, which according to Cochran-Smith and Lytle (1993

& 2009), consists of “the systematic, intentional study by educators of their own professional practice” (Dana et al., 2013, p. 241). The process of engaging in action research consisted of five elements: “learning what action research is; defining and refining a personal question for exploration; creating a plan for action research; collecting and analyzing data; and sharing what was learned with others” (Dana et al., 2013, p. 244). Thirty teachers participated in the study, which used Illuminate sessions, email, and telephone conferencing to structure small work groups. Teachers had opportunities to share and report out on their research projects, which involved engaging in a topic of interest. Findings revealed the benefits of engaging in action research in an OLC were: 1) sustained long-term action research over many months, 2) flexibility and choice of research questions, and 3) learning from other teachers. However lack of “time and communication with supervisors about action research” were major challenges (Dana et al., 2013, p. 255). This study also has implications for eCALLMS module development. While eCALLMS modules were designed with the principles of action research in mind, they do not promote formal engagement with action research. However, teachers who complete eCALLMS modules will have the opportunity to engage in specific strategies with multilingual learners and report back to the group using virtual tools as a form of professional learning grounded in the action research.

According to Lieberman and Mace (2010), meaningful teacher learning takes place when teachers initiate their own professional development by choosing online learning opportunities that best match their needs. Teacher-initiated professional learning often happens in informal ways (Rodesiler, 2011). For instance, according to Trust (2012), teachers can create personal online spaces (i.e. Classroom 2.0, Edmodo, etc.) where they can join interest groups, collect resources and self-direct their continued professional growth. eCALLMS modules, due to their

flexible nature, are capable of meeting teachers' "just-in-time" learning needs as they can be started at any time that is useful to the module participants, are low cost (currently, free!), and provide information upfront regarding the learning teachers will engage in to support self-selection. eCALLMS modules are designed to be multimedia, interactive resources that support meaningful collaboration and learning for groups of teachers interested in becoming linguistically responsive (Lucas & Villegas, 2011). While our work is ongoing, it will certainly add to the research literature on the use of synchronous and asynchronous tools to conduct professional development on academic language learning in mathematics.

Theoretical Framework

Our work is grounded in sociocultural theory where teaching and learning are understood as social and cultural acts that are situated in contexts where meaning is constructed and negotiated (Gee, 1996; Tharp, Estrada, Dalton, & Yamauchi, 2000). While meaningful collaboration and interaction are important in sociocultural theory, so are actors' beliefs, ideologies, life experiences, and backgrounds in understanding and engaging in their context (Gee, 1996). From this perspective, teaching and learning are deeply contextualized and situated in the interactions and negotiations of teachers and students. Johnson (2006) provides a valuable description of sociocultural theory:

From the epistemological stance of the sociocultural turn, knowledge that informs activity is not just abstracted from theory, codified in textbooks, and constructed through principled ways of examining phenomena, but also emerges out of a dialogic and transformative process of reconsidering and reorganizing lived experiences through the theoretical constructs and discourses that are publicly recognized and valued within the communities of practice that hold power. (pp. 240-241)

From this perspective, the modules under investigation are the spaces where *dialogic and transformative process* can occur to help teachers “reconsider and reorganize” their instructional practices and “lived experiences” in the classroom as they work to help multilingual learners develop strong mathematical knowledge and academic language skills. Further, sociocultural theory has informed the development of the CREDE standards of effective pedagogy, a guiding framework for the creation of the modules as well as a framework that research has demonstrated to substantially support the learning of multilingual learners in various settings (Doherty, Hilberg, Epaloose, & Tharp, 2002; Teemant & Hausman, 2013; Tharp, et al., 2000).

Methods

Sample

Twelve mathematics teachers were enrolled in a mathematics education course at a land grant university in the western U.S. Examining the fractions module was a part of the mathematics education course and was open to all students; however, only teachers who provided their voluntary consent under separate IRB approval were selected to participate. Teachers were provided additional points for their participation and were not graded. All of the teachers taught grades between 4th and 8th and had between two and five years of teaching experience. The teachers were working toward a master's degree in mathematics education.

Procedures

The participating teachers worked on the fractions module asynchronously and at their own pace. Consequently, they had a full semester or 15 week period to complete the module. Participating in the module review did not place a burden on the teacher's regular teaching schedule because it was not required to use the activities with their students. As the research questions state, we aimed to gather data to better understand the perceptions of mathematics

teachers doing professional development using an online platform. The eCALLMS module review used survey instruments (open/closed) to collect data and analyze mathematics teachers' perceptions of the fractions module. The questionnaire (see Appendix A) consisted of 13 items of which five used a 5-point Likert scale to rank the responses. The scale ranged from 1 (Strongly Disagree) to 5 (Strongly Agree) and was used to categorize each teacher's response to the questions. The other eight questions were open-ended and were analyzed using line by line coding. We coded responses from questions six through ten, as they illustrated salient responses to our research questions. Second level coding included collapsing initial codes into more theoretical themes.

After coding the data to find themes, we used the constant-comparative method (Strauss & Corbin, 1990) to analyze the open-ended response items on the aforementioned survey. This method was used to categorize statements made about the quality of the module. Thus, teacher comments provided constructive feedback to refine the module and inform the development of new modules.

Results

This study asked and answered the following questions: "What are mathematics teachers' perceptions of an online professional development module focused on fractions?" and "How do mathematics teachers perceived the value of the fractions module?" Overall, the mathematics teachers' opinions and perceptions of the fractions module were comprehensive revealing strengths, weaknesses, examples of how the module supported their learning and collaborative efforts, and ways to improve the module. We first discuss the results of the closed survey items followed by a discussion of salient themes from the analysis of the open-ended questions on the questionnaire.

Closed Survey Item Analysis

Through the responses to questions on the survey, our research participants demonstrated various perspectives on the eCALLMS mathematics fraction module. Eighty-five percent of respondents either agreed or strongly agreed that the fractions module provided the kind of learning experiences that would allow participants to meet the learning objectives stated in the module. One hundred percent of the participants found the module accessible and easy to navigate. Ninety-five percent of the participants felt that it was clear what was expected of them to complete the module, but only fifty-five percent felt that the one-week timeline per theme or topic was sufficient to meaningfully engage with the content of the module. Finally only 25% of respondents felt that the module supported the implementation of WiDA standards.

These data suggest that the majority of the mathematics teachers think that the fractions module was simple to navigate, contained clear learning objectives that matched the activities participants were being asked to complete, and that the expectations were clear. However, mathematics teachers were split about their decisions regarding the completion timeline and WiDA standards implementation, having concerns about one week not being enough time to complete a topic as well as not understanding what the WiDA standards are and their purpose.

Strengths of the Module

Our analysis regarding the value of the fractions module suggests three important themes: (1) organizational structure; (2) holistic modes of processing information; and (3) teacher-friendly resources. As described above, every module designed in the eCALLMS project was specifically organized to include an *Explore*, *Make it Work*, and *Share* section for each week.

Our participants found the organizational structure as a strength of the module. One participant reported that “this module made excellent use of the ‘I do, we do, you do’ sequence.”

Another participant commented that he or she “liked how they [designers of the module] broke down what the teacher could expect, and they modeled and gave pictures with their examples.” A participant also shared: “It stated the objectives before starting the video, great visuals of different fractions in the real world, and the concept definition model is a great tool to organize the information learned.” These statements suggest that mathematics teachers appreciate clear learning objectives and leveled modeling (Duke & Pearson, 2002; Fisher & Frey, 2008; Frey & Fisher 2010), a strategy that emerges out of literacy and guided reading, but also one different teachers can relate to and, in fact, use in the classroom when scaffolding new learning with their own students. We liken leveled modeling to the gradual release of responsibility, which can empower teachers to improve their teaching practice since there are opportunities to practice without penalty. As the literature points out, changing a teacher’s practice such as learning how to develop academic language among multilingual students in a mathematics classroom requires a shift in behavior (Pajares, 1992; Tan, 2011).

Another strength our research participants reported on the fractions module was the holistic modes for processing information. Some of the ways participants were able to receive and process information included watching and analyzing videos, interviewing and listening to their students’ language, and reflecting on their learning in various ways. The statements below illustrate this theme:

“The video is the strongest part of the module.”

“...I also thought the interview with a student... to scaffold language was a strength. As always, I think a reflection section is pertinent to growth and understanding.”

“Giving students options on how to share what they learned is good. Questions and ideas to generate their thoughts about what they learned are good. The survey was a good idea for the students to reflect and gain more insight on what really helped them learn the language.”

These statements suggest that mathematics teachers liked having different ways to learn new material. The modules were designed to include multiple ways of learning, which undergirds sociocultural theory. Through this work we helped mathematics teachers reconsider their instructional practices to try out new ideas for supporting multilingual learners and pushed them to consider students' learning styles and negotiate the "lived space" of knowledge construction. Although the modules were asynchronous and unfacilitated, the various learning activities acted as a proxy for a live facilitator and still provided the teachers with opportunities to be in charge of their own learning in order to discover new ideas, gain insights, and make connections.

Another strength of the fractions module was that it provided teacher-friendly resources. The modules included graphic organizers and virtual manipulatives, and "chunked" background information into digestible parts. One participant stated:

"The make it connections slide is good. I would consider using this in my class. I like the fraction wheels. It is a really good idea and your explanation and pictures of this are great! You should include more stuff like this in the modules!"

A second participant commented that he or she thought that the "fraction bars, the methods, and the visual representations reinforced by numeric algorithms were the biggest strengths." A third mathematics teacher responded that the "strengths of the module were the graphic organizers. I think that these are very valuable for moving conceptual understanding on the learning continuum." Each of the comments above reveals that mathematics teachers appreciate resources and tools that assist them in the teaching and learning processes of their students. Manipulatives such as fraction bars and the use of graphic organizers provide teachers and students with concrete strategies for deepening their understanding of how to unpack the language of fractions. The various resources acted as *tools* also for mathematics teachers to use in engaging in the

share part of the modules and provided a space for the teachers to construct meaning with each other; another important aspect of socio-cultural learning theory.

Weaknesses of the Module

We also asked participants to think about the weaknesses of the fractions module. Two important themes emerged from the analysis of their responses: (1) narration of the videos and (2) timeframe. Several participants pointed out that the narration of the videos included a monotone speaker, slow pacing, and simplistic content. Below are responses from mathematics teachers:

“Spoke too slowly, which can cause a loss of interest very quickly.”

“Speaker in the videos is slow and monotone, objectives perhaps need to be stated in the video.”

“The introduction video was slow-paced and dry.”

“The introductory video had a voice that was way too slow for the intended audience. The tone was pleasant, however the pace and content should be revved up a bit, if these videos are for practicing teachers. Otherwise, I feel practicing teachers would disregard the content as irrelevant, as the pace feels a bit condescending.”

These comments reveal that future modules should be careful to narrate videos in a way that includes a quicker pace and more complex content. The comments were consistent with feedback received from experts in the field of mathematics education and were utilized to improve the module before it became publicly available.

Evidence of Learning and Collaborating

We asked participants what type of *exchanges* they would expect to see as evidence of learning and collaborating in the modules. Themes that emerged from their responses include: 1) development of an inquiry stance; 2) practice of critical reflection; and 3) facilitation of feedback. Mathematics teachers reported that having a stance of inquiry would be evidence that

respective teachers are learning and collaborating. Inquiry includes discovering, exploring, asking questions, and being open to seeing new potentials and possibilities. One participant stated, "Collaborating is working together. Therefore, asking questions, making suggestions, or requesting further explanations should be a part of this process. We must work together and use other's ideas to improve upon our own learning." A different mathematics teacher reported that he or she "would expect to see a give and take between teachers regarding a new found appreciation for the difficulties faced by multilingual learners." Another participant commented that he or she would "expect to see good questions, suggestions, and comments as well as reflections about what they are learning or what maps and models are being shared." These comments illustrate that learning how to develop academic language in the mathematics classroom requires teachers to ask generative questions, seek answers to those questions, and build their knowledge by being in dialogue with colleagues with similar and different experiences and worldviews—all critical features of socio-cultural learning theory.

Practicing critical reflection can be a challenging process for teachers; however, mathematics teachers in this study reported that it was a necessary disposition to support learning. Below are comments by several participants:

"I would expect teachers to do a plus/delta about what they learned after collaborating, and how they are going to manipulate new ideas in their classrooms."

"I would expect to see teachers exchanging information from the funds of knowledge, student interview, etc., and sharing, comparing, and making connections for students with the same linguistic backgrounds. Then using these connections and reporting to each other their successes and improvement."

"Teachers should be sharing what they do in their classrooms and what they will change. They should be sharing which methods were most difficult for them to understand."

"I would expect to see teachers collaborate about what worked well, what they would do differently the next time they taught it, and maybe give samples of student work."

These responses reveal that inquiry stance and critical reflection are interconnected. Verbs participants used, such as *compare/contrast*, *manipulate*, *make connections*, and *share*, demonstrate critical thinking processes necessary to be authentic in the reflexive process. Critical reflection also calls for teachers to check their assumptions and try alternative interpretations. Since we know that elementary teachers are ill-prepared to provide opportunities for multilingual learners to acquire academic language in mathematics classrooms (Lucas et al., 2008; Nevarez-La Torre et al., 2008; Silva et al., 2012), development of online professional development modules is essential and timely work. Being critical of one's own ideas, values, and beliefs is important for reaching the goal of positively transforming multilingual learners' experiences in mathematics.

Finally, the participants' responses suggested multi-way facilitation of feedback as another avenue to demonstrate learning and collaboration. Facilitation is an active process that requires all parties involved to participate as learners, developers, and problem solvers—not the keepers of knowledge. Teachers pointed out that having feedback from each other as well as from module designers is important for learning. A mathematics teacher pointed out that “having a site for teachers to post their ideas and give us great feedback as to whether we are on the right track for teaching bilingual students” is important. A different participant stated:

“I would expect to see [teacher generated] videos, artifacts, and threaded discussions concerning the module at hand. Many teachers are unfamiliar with valid teaching strategies when it comes to fractions overall, and especially strategies for ELLs. Having a mentor teacher available to have online exchange or question/answer format would be helpful.”

Another mathematics teacher reported the following:

“I think it would be good to share activities that went well for bilingual students and for teachers to explain why. When the lessons are posted with comments about how to accommodate the specific needs for students, the lessons can go much smoother. Also, when teachers point out certain situations that came up about how a student

misunderstood a concept and why, then it is easier for us to be on the watch for next time or know how to modify those lessons.”

These responses reveal that teachers desire to improve their practice regarding language development in mathematics for multilingual learners. Comments also reveal that mathematics teachers desire informal feedback—daily exchanges between teachers, but also desire more formal feedback from individuals with credibility on ways to do this work effectively. While wanting to know if they are doing the work “right” is commendable, this work is about the systematic study of complex interactions and experiences with students, colleagues, researchers, etc. Receiving feedback from multiple colleagues is critical because it helps teachers to maximize their potential at different stages of this work, raise their awareness of strengths and areas for improvement, and identifies actions to be taken to improve performance. This is the role of all teachers aiming to learn how to support multilingual learners in language development for mathematics.

Improving the Modules

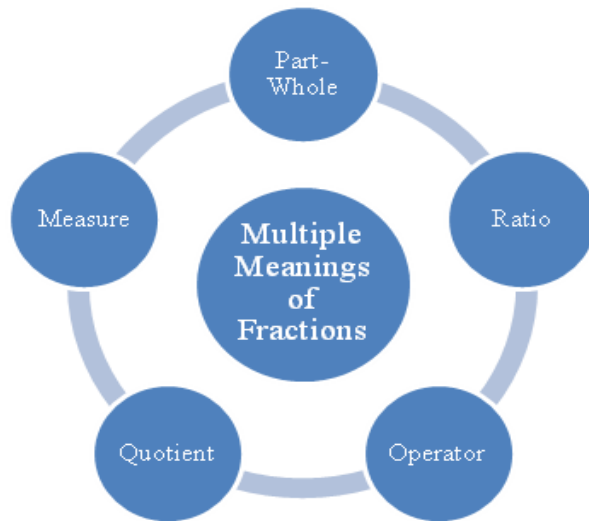
Overall, participants’ suggestions for ways to improve the modules triangulated with the weaknesses, particularly the narration of the videos. Mathematics teachers commented that having sample videos of lessons being taught by experienced teachers would give future teachers ideas and ways of manipulating concepts to fit their teaching styles. They also pointed out that having examples of ways to reteach if students do not clearly meet the learning objectives would be helpful.

Mathematics teachers also commented that more examples of various concepts included in the module would be helpful. For example, one participant stated: “...add slides and information or examples for all of the interpretations not just for the part-whole.” This participant was referring to an activity where teachers had to choose a different meaning for

fractions beyond part-whole (i.e., a typical meaning in most elementary mathematics textbooks). They had to self-study one that was unfamiliar to them (refer to Figure 2). Although, teachers wanted more examples, part of the learning is for them to seek out information on their own, which has more power for buy-in and long-term investment and enhances retention of the concepts.

Overall, the results of this study suggest the eCALLMS modules are promising online professional learning opportunities for mathematics teachers who work with multilingual students. The results concur with the findings of Lucas et al. (2008) that language learning and academic language cannot be disentangled and with the findings of Dana et al. (2013) and McConnell (2013) that asynchronous text-based platforms are cutting-edge and effective forms of professional development.

Figure 2. Multiple meanings of fraction.



Implications

Overall, there are several implications for future professional development and the support of mathematics teachers' work with multilingual learners. First, it appears that further

opportunities to engage online with other teachers and knowledgeable experts are a desirable way for teachers to seek information to improve their practice. The eCALLMS modules are one way for this to occur, but content and language specialists (especially those living at the intersection of both) should consider ways to make their expertise meaningfully and readily available to teachers online. Perhaps more online courses should be offered, blogs where experts post suggestions and interact with teachers should be created, or even online forums or Wiki spaces should be utilized. This research suggests there is great value in taking advantage of online environments to support ongoing teacher learning for working with multilingual learners.

Second, it appears that different types of modalities for professional development are crucial to advance the learning of new information that can be presented and shared with teachers. Several respondents had quite different responses as to what was valuable for them in the modules. Therefore, substantial variation in modalities and activities to support teacher learning appears important in order to maximize the learning benefit among mathematics teachers. And finally, it does appear that there is great benefit for pushing content teachers to think and act meaningfully in order to support language development for multilingual learners. By meaningfully integrating that work with content knowledge development, teachers are seeing important ways to improve the education and outcomes of multilingual learners in regular content classrooms.

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Appendix A

External Feedback

Thank you for looking at our eCALLMS modules. We appreciate your perspective regarding how they can be improved. Please respond to the following prompts to share your perspectives on our work.

NAME OF MODULE HERE

Indicate your agreement with the following three statements by circling the appropriate letter.

1. The module provided the kind of learning experiences that would allow participants to meet the learning objective stated in the module? [Restate the learning objective here.]

- A Strongly agree
- B Agree
- C Undecided
- D Disagree
- E Strongly disagree

Any additional comments? [comment box]

2. The module was easy to navigate.

- A Strongly agree
- B Agree
- C Undecided
- D Disagree
- E Strongly disagree

Any additional comments? [comment box]

3. Participants know what is expected of them.

A Strongly agree

B Agree

C Undecided

D Disagree

E Strongly disagree

Any additional comments? [comment box]

4. Each week teachers are given a new theme or topic to explore, make it work and then share. The one-week timeline is sufficient to meaningfully engage with the content.

A Strongly agree

B Agree

C Undecided

D Disagree

E Strongly disagree

Any additional comments? [comment box]

5. These modules will help teachers meaningfully implement the WIDA standards into their classroom practice. *(You may skip this if you do not feel confident making judgments about the use of the WIDA standards).

A Strongly agree

B Agree

C Undecided

D Disagree

E Strongly disagree

Any additional comments? [comment box]

6. What did you think were the strengths of the module?
7. What did you think were the weaknesses?
8. In what ways do you think this module could help teachers improve their practice with multilingual learners?
9. In what ways should this module be improved to most help teachers improve their practice with multilingual learners?
10. As you know, teachers engage in dialogue in the modules and share their work.
What would you expect to see in these exchanges to know that teachers are successfully learning?
What would you expect to see in the exchanges to know that teachers are successfully collaborating?
11. Is there anything in the content of the module that conflicts with your understanding of or perspective regarding the topic (not simply new information)?
12. Any other impressions, ideas or overall feedback you can offer us?

Thank you!