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Development and Assessment of a Continuing Education Unit in Quantitative Literacy for High School STEM Teachers

Abstract

Influencing the teaching of quantitative literacy at all levels of education can be difficult due to the many demands placed on educators. In a continuing education course, public high school science teachers participated in a pilot study of a program on quantitative literacy, involving defining quantitative literacy, how it is beneficial to students, examples of quantitative literacy education, and how it may be supported in the science classroom. Surveys administered before and after the unit indicate an improvement in the teachers' understanding of quantitative literacy, and a follow-up survey indicates that the unit impacted classroom practice. Results support the conclusion that this program for secondary educators in science fields has a positive effect on their willingness and ability to teach quantitative literacy and may be an effective approach to supporting numeracy education at the secondary level.

Keywords

quantitative literacy, teacher education, continuing education, secondary education

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Cover Page Footnote

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Introduction

As Lynn Steen declared, every teacher is a teacher of mathematics (2007). In order for every teacher to teach mathematics, they must have an understanding of the quantitative literacy of their students and how to effectively convey related mathematical concepts in the classroom. For students to develop quantitative literacy skills, they must be introduced to the universal nature of quantitative literacy through introduction to quantitative topics through multiple courses, and in contexts appropriate to each subject. However, these necessities may be difficult for multiple reasons. In order to allow for effective quantitative literacy education in their fields, teachers need to be introduced to quantitative literacy, educated about the benefit to their students, made comfortable in conveying numerical topics and strategies, and given tools to be able to teach subject topics in a way that enforces their students' development of quantitative literacy.

Secondary education is an appropriate level at which to guide students in a greater exploration of quantitative literacy. Using subject-specific analysis can help develop an understanding of contexts where quantitative communication is appropriate. Typically in secondary school, students become more exposed to mathematical questions in context (word problems) and are required to apply their mathematical knowledge to solve problems in new situational contexts. A recent study has shown that traditional mathematics courses may not be effective in developing quantitative reasoning skills (Agustin et al. 2012). Courses focusing on the application of mathematical concepts in different contexts may both aid in developing quantitative reasoning and develop a deeper understanding of mathematical principles. In applying mathematics to solve numerical problems, students must identify the problem type and translate quantitative information from the problem into a mathematical context (Geary 2000). As such, secondary schooling is a candidate level for integrating additional quantitative literacy concepts into the curriculum.

To support student understanding of quantitative literacy in the classroom, teachers must have an understanding of quantitative literacy, and how to develop these skills in their students. Teacher behaviors in the classroom, especially those which support higher-order thinking skills, have been found to have a larger influence on student achievement in mathematics than other factors such as student socioeconomic status and teacher professional development (Wenglinsky 2001). Some initiatives show potential to increase the teaching of quantitative literacy in schools but may be limited to pre-service teachers (Watson 2011; Forgasz et al. 2017). For a more effective integration of numerical topics into the curriculum, continuing education courses for current teachers may be a venue for introducing methods on integrating quantitative literacy into their teaching.

To support teaching quantitative literacy at the secondary level, a five-week quantitative literacy workshop was developed to introduce high school science teachers to quantitative literacy. As five weeks is a short amount of time to cover any topic in depth, this workshop was intended to pilot a program in teacher education to assess whether the approach used could have a positive impact on how these teachers view and address quantitative literacy in the classroom. The content of the unit was based around multiple representations of quantitative data and how approaches using multiple representations may benefit student understanding (Kaput 1989; de Jong et al. 1998). The workshop was presented in a hybrid in-person and distance learning format as a unit of a larger continuing education course. Surveys were administered to the participants before and after the course to assess the teachers' experiences in the program and their attitudes about emphasizing quantitative literacy in their classrooms. Recent work by Nuhfer et al. has shown that these self-assessments may provide valid information of the respondents' abilities and proficiencies (2017).

Course Format

The quantitative literacy unit was taught as the first unit of a six-month continuing education course for current high school teachers of biology, chemistry, and physics in the public school system of Birmingham, Alabama. There were two cohorts in this program: Fall 2013–Spring 2014 and Fall 2014–Spring 2015. The quantitative literacy unit started the course with a five-week unit with weekly assignments, followed by a five-month subject-specific focus for teachers of each discipline. The quantitative literacy unit included specific goals considered to be the most important objectives of the pilot in order to introduce the teachers to quantitative literacy in a short time. The stated goals of the course were focused on developing the teachers' understanding of quantitative literacy and how these topics may be implemented in their classrooms. The stated goals were:

1. Be able to define quantitative literacy.
2. Be able to describe how an individual's quantitative literacy may be assessed.
3. Be able to explain how quantitative literacy is important in civic engagement.
4. Be able to understand and explain how an understanding of quantitative literacy is important in interpreting quantitative information in the media or other public sources.
5. Be able to explain how collaborative work can contribute to quantitative literacy in the classroom.
6. Be able to identify ways in which quantitative literacy may be fostered in the classroom

7. Be able to identify and explain how different individuals may approach quantitative problems differently.
8. Be able to identify areas in the individual's area of expertise in which quantitative literacy is important.

The unit started with an introductory in-person session, followed by five weekly online assignments and feedback, and a final in-person meeting at the conclusion of the quantitative literacy unit. The in-person meetings were used to foster discussion and exploration of quantitative literacy, while the online assignments were based on assigned readings and individually assigned activities. Another in-person meeting at the end of the six-month course was used for a final assessment of the course (Figure 1).

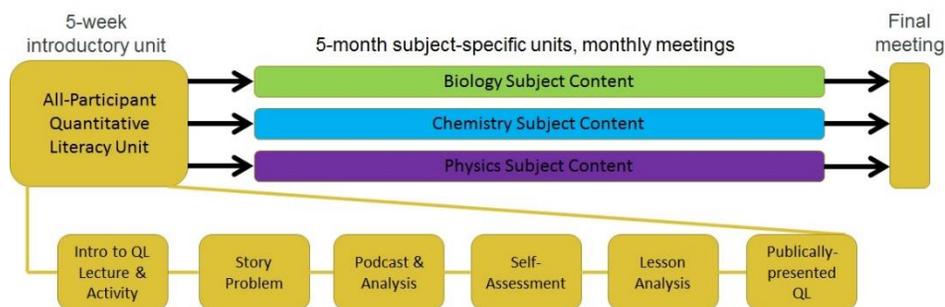


Figure 1. Structure of the high school teacher continuing education course

For the first class meeting, a lecture on quantitative literacy was delivered (1) defining quantitative literacy, (2) differentiating quantitative literacy and mathematics, (3) examining characteristics of quantitatively literate individuals, (4) presenting a study showing a correlation between quantitative literacy to full-time employment (Rivera-Batiz 1992), and (5) comparing quantitative literacy to the Next Generation Science Standards and the Common Core State Standards for Mathematics. Participants then completed a guided inquiry activity as a group to introduce them to quantitative literacy concepts, and they were given two articles to read for the first weekly assignment—Steen (2007) and Hallett (2003). For the first week's assignment, participants were asked to fill out a worksheet with their impressions of the articles, how they have seen quantitative literacy used in their classrooms, and difficulties that students have in their classes when they lack quantitative literacy skills.

For the second assignment, participants were asked to complete a story problem and write down all of their thoughts and efforts as they worked through the problem. The problem, drawn from Watson (2011), was selected due to its difficulty and ability to be solved through a variety of different strategies. After

completing the problem, participants were asked to scan their work and e-mail it to the instructor who collected these recorded responses and removed participant names before redistributing them the following week.

For the third week's activity, a podcast lecture of the Rule of Four was presented to describe how different approaches may be used to present quantitative data (Make It Real Learning Company 2012). Each participant was given two worked solutions from the previous week's activity to examine each for how the solver used numerical, graphical, symbolic, and verbal approaches to solve his or her problem. The distributed solutions included both correct and incorrect answers to the problem and were selected to give a variety of numerical answers to illustrate different approaches to the same problem. Each participant was asked to complete a worksheet analyzing the responses to these different approaches and the advantages of each approach.

For the fourth week, participants were given a copy of their own completed problem from week 2, along with a solution to the problem. The participants were also provided with a quantitative literacy rubric to complete a self-assessment of their approach to the problem from Fresno State University (2014). With this self-assessment, the participants were challenged to identify how they approached the problem and recognize how other quantitative approaches could be used in order to solve the problem.

In the final weekly assignment, participants were asked to complete a worksheet in which they were to (1) select a standard from the Common Core State Standards for Mathematics which they believed was especially important for their students, (2) indicate how it fits into the content that they teach, (3) share what difficulties they have seen students have with this standard, and (4) explain how they could use multiple approaches from the Rule of Four to help their students grasp this concept. This final assignment was designed for them to identify an application of quantitative literacy in the curriculum and how it may impact their students' performance.

The final session for the course was a second in-person meeting. In this session, a short lecture was presented on misrepresentations of quantitative information in the media, how quantitative data may be used to mislead the public, and appropriate questions to ask about quantitative information presented in the media. Participants then worked in groups on worksheets designed to foster critical analysis of data presented in various media sources.

During the two in-person meetings from the first and last weeks of the unit, surveys were administered to gauge the participants' familiarity with quantitative literacy and their opinions on quantitative skills. A follow-up survey was also conducted at the completion of the continuing education course (five months after the completion of the quantitative literacy unit) to determine if the quantitative

literacy unit at the beginning of the course had any long-term effect on the teachers' attitudes about quantitative literacy and classroom practice.

Survey Instruments

All participants in the program and study were current teachers in the Birmingham, Alabama public school system and participated in the program while earning continuing education credits. This program was advertised in the public school system, and 17 teachers enrolled in the program in the first year, with 19 enrolling in the second year. Only those participants present in the program meetings at both survey times (12 participants in each cohort) were able to be included in the data analysis.

The pre-unit survey for the course consisted of nine statements to which participants rated their agreement on a seven-point Likert-type scale (Likert 1932). The possible responses ranged from "Strongly Agree" to "Strongly Disagree" for each statement. The same set of survey statements was used in the pre-unit and post-unit surveys to allow for a comparison of participants' opinions through the course. The questions probed the participants' understanding of quantitative literacy, feelings of the importance of quantitative literacy, and knowledge of how to support quantitative skills for their students. With the common set of statements, changes in attitudes about quantitative literacy for participants could be determined. The post-unit survey also assessed participants' agreement with 14 additional statements and solicited free-response reactions to the quantitative literacy unit. Analysis of responses was limited to those who completed at least half of the weekly assignments for the unit, so were judged to adequately participate in the program (7 of the 12 participants in each cohort were present for both the pre- and post-unit assessments). Finally, five months after the quantitative literacy unit had concluded, a survey including six statements about classroom practice and a free-response section was administered at the close of the continuing education course.

The survey instruments were designed to gather information on the participants' self-assessment of whether the aforementioned goals were met through the program. Due to the short timeline and small sample size, validity and reliability of the survey instruments was not able to be established.

Results and Discussion

In the pre-unit and post-unit surveys, program participants were asked to rate their agreement with nine statements, using a seven-point Likert-type survey with responses ranging from "Strongly Agree" (1) to "Strongly Disagree" (7). For participants completing the pre-unit and post-unit surveys, responses on the paired questions were compared using the Wilcoxon Signed-Rank Test (1945). Results are

presented in Table 1, divided by cohort. A lower post-unit mean response indicates greater agreement with each statement after the unit than before. Twelve participants in each cohort completed both the pre-unit and post-unit surveys, allowing for comparison of their responses. In the Wilcoxon Signed-Rank Test, N represents the number of individuals whose responses changed between these two surveys, and those surveys are used for further analysis. Statistical significance is indicated by the magnitude of W for $N < 10$, and by the z -score for $N \geq 10$.

Table 1
Pre-/Post-Survey Question Comparisons for the Quantitative Literacy Unit

Survey prompt	Pre-unit mean response	Post-unit mean response	N	W	z -score
1) I believe that I have a firm understanding of what quantitative literacy means. (Goal 1)	3.3 +/- 1.0 ('14)	1.7 +/- 0.6 ('14)	11	66	2.91
	3.9 +/- 1.4 ('15)	1.9 +/- 0.3 ('15)	11	77	3.40
2) I am able to reliably assess the level of quantitative literacy that my students possess. (Goal 2)	3.5 +/- 1.1 ('14)	2.6 +/- 0.9 ('14)	10	41	2.06
	4.1 +/- 1.6 ('15)	2.3 +/- 0.7 ('15)	9	45	2.64
3) Quantitative skills are important in daily life. (Goal 4)	1.4 +/- 0.7 ('14)	1.5 +/- 0.5 ('14)	7	-7	-0.63
	1.6 +/- 0.5 ('15)	1.3 +/- 0.5 ('15)	8	18	1.23
4) In my classes, the students need a good understanding of quantitative relationships to succeed. (Goal 8)	1.5 +/- 0.5 ('14)	1.9 +/- 0.8 ('14)	6	-21	-2.25
	2.7 +/- 1.3 ('15)	1.8 +/- 0.6 ('15)	7	22	1.82
5) Quantitative literacy has strong links to the assessments that are used in my school. (Goal 8)	2.8 +/- 1.1 ('14)	2.5 +/- 1.1 ('14)	10	7	0.33
	2.6 +/- 0.8 ('15)	2.3 +/- 1.1 ('15)	11	24	1.04
6) I have knowledge of how to help students build quantitative skills. (Goal 6)	3.5 +/- 1.1 ('14)	2.4 +/- 0.5 ('14)	9	45	2.64
	4.2 +/- 1.6 ('15)	2.3 +/- 0.9 ('15)	9	45	2.64
7) Quantitative skills are important for individuals to be educated members of society. (Goal 3)	1.5 +/- 0.5 ('14)	1.6 +/- 0.5 ('14)	8	-4	-0.32
	1.8 +/- 0.8 ('15)	1.5 +/- 0.7 ('15)	8	15	1.02
8) I feel that collaborative work is important in developing quantitative skills. (Goal 5)	1.8 +/- 0.8 ('14)	1.5 +/- 0.7 ('14)	10	15	0.74
	1.7 +/- 1.0 ('15)	1.8 +/- 1.1 ('15)	6	0	-0.05
9) It is important for me to stress quantitative skills in my classes. (Goal 8)	1.4 +/- 0.5 ('14)	1.6 +/- 0.7 ('14)	5	-9	-1.28
	2.3 +/- 1.0 ('15)	1.7 +/- 0.7 ('15)	9	29	1.69

Changes in response were significant to the 95% confidence level or greater for four of the nine statements on the pre-term and post-term surveys for the 2014 cohort, with three changes being positive (greater agreement) and one being negative. The 2015 cohort showed significant changes in five of the nine statements, all indicating an improvement in participant beliefs about aspects of quantitative literacy. The questions generating evidence of improvement were:

- 1) I believe that I have a firm understanding of what quantitative literacy means ('14 and '15).
- 2) I am able to reliably assess the level of quantitative literacy that my students possess ('14 and '15).

- 4) In my classes, the students need a good understanding of quantitative relationships to succeed (negative in '14; positive in '15).
- 6) I have knowledge of how to help students build quantitative skills ('14 and '15).
- 9) It is important for me to stress quantitative skills in my classes ('15).

Overall, these results show a significant improvement in the agreement with these statements for participants over the term of the quantitative literacy unit. The changing agreement with these statements was positive in all cases, except for statement 4 in the 2014 cohort. Although this change was negative in 2014, a positive change was observed in the 2015 cohort for the same statement. In examining the statement level of agreement with this statement prior to the quantitative literacy unit, there was a greater agreement with the statement at the beginning of the 2014 cohort program, so a decrease in the agreement with the statement would be easier to observe. Data analysis with the combined cohorts shows no significant change in attitudes, as the different results in the two cohorts in the opposite directions then negate the overall change.

It is noted that three of the other survey questions (3, 7, and 8) had high agreement prior to the quantitative literacy unit (Strongly Agree or Agree for most participants), so it is acknowledged that a significant increase in participants' agreement with these statements would be difficult to observe with the small sample size. The survey responses indicated that several of the goals of the quantitative literacy unit were supported, and the participants found it to be helpful in achieving these goals.

For each of the Likert-type statements on the post-unit survey without corresponding pre-unit statements, the percentage of respondents for each level of agreement with the statements were tabulated. For ease of analysis, responses were grouped as positive ("Strongly Agree" or "Agree"), neutral ("Somewhat Agree" to "Somewhat Disagree"), or negative ("Disagree" or "Strongly Disagree"). Percent of participants responding in these divisions for the surveys for each cohort are presented in Table 2. The goals associated with each of the survey questions are noted next to each question in the table.

In the post-unit surveys, the majority of the participants selected "Strongly Agree" or "Agree" with each of the statements, indicating strong support for the goals of the quantitative literacy unit. The one question to which the majority of participants selected "Agree Somewhat" through "Strongly Disagree" was the statement indicating that the work for the unit was excessive. Therefore, the workload for the unit was judged to be appropriate for the majority of the participants in the program.

Table 2
Post-Unit Survey of Attitudes of Quantitative Literacy Unit Participants*

<i>After completing the quantitative literacy unit in this program...</i>	<i>Strongly Agree or Agree</i>	<i>Agree Somewhat or Neutral or Disagree Somewhat</i>	<i>Disagree or Strongly Disagree</i>
10) I would be better able to explain to a friend/colleague what quantitative literacy means. (Goal 1)	100% ('14) 100% ('15)		
11) In this unit, my knowledge of how to help students build quantitative literacy skills has increased. (Goal 6)	71% ('14) 86% ('15)	29% ('14) 14% ('15)	
12) I found this unit to be interesting.	86% ('14) 100% ('15)	14% ('14)	
13) I would recommend this course to my colleagues who are science teachers. (Goal 8)	86% ('14) 100% ('15)	14% ('14)	
14) I am more likely to use collaborative work in helping students to develop quantitative skills and/or discipline-specific knowledge. (Goal 5)	83% ('14) 86% ('15)	17% ('14) 14% ('15)	
15) I believe I am better able to analyze quantitative information presented publicly and offer a critique on its validity. (Goal 4)	71% ('14) 71% ('15)	29% ('14) 29% ('15)	
16) The amount of time required in order for me to complete assignments was excessive.	14% ('14)	43% ('14) 71% ('15)	43% ('14) 29% ('15)
17) I am more likely to stress quantitative skills in my classes. (Goal 8)	71% ('14) 86% ('15)	29% ('14) 14% ('15)	
18) I have a better understanding of different approaches individuals may take to solve quantitative problems. (Goal 7)	86% ('14) 86% ('15)	14% ('14) 14% ('15)	
19) This unit was beneficial to my development as an educator.	86% ('14) 100% ('15)	14% ('14)	
20) The format of the E3 online quantitative literacy course was appropriate for me.	86% ('14) 86% ('15)	14% ('14) 14% ('15)	
21) My understanding of quantitative literacy is improved through this unit. (Goal 1)	100% ('14) 100% ('15)		
22) I am better able to assess students' quantitative literacy skills. (Goal 2)	86% ('14) 71% ('15)	14% ('14) 29% ('15)	
23) The course instructor provided effective feedback to me.	83% ('14) 71% ('15)	17% ('14) 29% ('15)	

*Note: N=7 in each cohort.

The post-unit survey also asked participants to rate the overall unit as Excellent (3 responses), Very Good (8), Good (2), Fair (0), or Poor (0). Additionally, participants were asked to state why they gave these ratings. Their responses are listed below.

- *I learned a lot of important information.*
- *I believe better feedback could have been given & more discussions.*
- *I thought this was fabulous. By having me reflect on my own quantitative literacy skills, I was better able to understand student thinking.*
- *I got a better understanding of quantitative literacy because of the lessons.*

- *My eyes were opened, and I was made aware of the details of QL. Before this course, I really did not have an understanding of the topic. It is very important, and this course has helped me understand its importance.*
- *The material covered was interesting and made me think about how I present data to my students.*
- *The instructor was very informative and knowledgeable of the content. The course work was relevant & pertinent. It included videos which spoke to my learning style.*

At the end of the continuing education course and five months after completion of the quantitative literacy unit, a second follow-up survey was completed to determine if the quantitative literacy unit had a lasting effect on the participants. This five-month post-course survey consisted of six statements to which participants rated their agreement on a seven-point Likert-type scale in addition to a free-response section allowing for additional reflections on the quantitative literacy unit. As in the previous survey instrument, participants who completed fewer than half of the assignments in the course were excluded due to their possible lack of familiarity with the unit assignments and objectives.

For each of the survey questions on the post-course survey, the percentage of respondents for each category is tabulated in Table 3.

Table 3
Survey of Attitudes of Quantitative Literacy Unit Participants Following Completion of the Continuing Education Course*

<i>Please mark the appropriate box indicating your level of agreement with each of the following statements as they pertain to the Quantitative Literacy unit of the AMSTI program.</i>	<i>Strongly Agree or Agree</i>	<i>Agree Somewhat or Neutral or Disagree Somewhat</i>	<i>Disagree or Strongly Disagree</i>
1) The quantitative literacy unit was an appropriate topic to start with in this program.	100% ('14) 83% ('15)	17% ('15)	
2) As a result of the quantitative literacy unit, I have changed my classroom practice to integrate some of the ideas communicated. (Goal 6)	86% ('14) 67% ('15)	14% ('14) 33% ('15)	
3) Since the start of this program, I have discussed quantitative literacy with colleagues. (Goal 1)	86% ('14) 67% ('15)	14% ('14) 33% ('15)	
4) I have added classroom materials or activities to emphasize quantitative literacy to my students in some topics. (Goal 6)	100% ('14) 83% ('15)	17% ('15)	
5) I have worked to evaluate (formally or informally) the quantitative literacy of my students. (Goal 2)	57% ('14) 50% ('15)	43% ('14) 50% ('15)	
6) In reflecting back on this program, the quantitative literacy unit was beneficial for me as an educator. (Goal 8)	100% ('14) 83% ('15)	17% ('15)	

*Note: N=7 in 2014; N=6 in 2015

The five-month post-course survey was included to determine if the unit had any long-term effects on classroom practice for the participants. On these surveys, the majority of the respondents indicated that their classroom practice relating to goals 1, 2, 6, and 8 had changed as a result of the unit. The results from the five-month post-course survey suggest the quantitative literacy unit influenced the

participants to develop the way they present quantitative information to their students and resulted in changes in their individual classrooms in supporting quantitative literacy.

Four participants in 2014 and two in 2015 also responded to the free-response portion, sharing their comments about the quantitative literacy unit:

At the beginning of this program I did not know what quantitative literacy was, but now I have found myself trying to incorporate it more in my lessons. Need more suggestions on how to create more activities using these skills. (2014)

It was helpful b/c it helped me learn to better evaluate my students and address any of my own issues. (2014)

The quantitative literacy helped me to teach my students how to use mathematical concepts to reinforce understanding of science, as well as master levels of comprehension in mathematics. (2014)

It was definitely eye-opening for me. The unit provided ways for me to analyze my students & then help them to increase their quantitative literacy. I was able to get a better grasp of how to do this in my specific content area. It also helped me to recognize my own level & to be more observant of real life examples. (2014)

It was difficult for me to incorporate this into my classroom. Taking the time to create lesson plans that are related to chemistry & incorporate QL would be a good addition. I do feel that I have these skills/understanding that I can incorporate in planning future lessons. (2015)

I thought the information shared was enlightening. I really loved the illustration (real-world examples) given to address how numbers may sway our thinking. I will incorporate more quantitative literacy in my future courses. (2015)

Conclusions and Significance of the Study

Overall the described continuing education unit met many of the goals that were considered in the design of the unit. The majority of high school teachers who participated in the program indicated improvement of their understanding of quantitative literacy and increased use of quantitative literacy in their classrooms.

One of the weaknesses of the quantitative literacy unit analysis was the small number of participants whose responses were analyzed in the survey data. This weakness is due to the small number of program participants who completed a majority of the assignments for the unit (seven of the twelve in each cohort). Review of statements regarding why participants did not complete the assignments indicated the most cited reasons for this were time constraints. Weekly assignments were given via the Trello online project management system, but for some participants, one week was not enough time to complete the assignment. However, due to the short nature of the unit (five weeks) and the need to address subject-specific content in other program units, the amount of time which could be spent on exploring quantitative literacy topics was constrained in the continuing education course.

Although there were a small number of participants in the study, it is also encouraging that, even with this small sample size, statistically significant changes were seen in the opinions of the participants, corresponding to several of the unit goals. Additionally, the fact that changes in classroom practice were reported for a relatively short unit on quantitative literacy gives an indication of the effect that these short courses may have on the practice of supporting quantitative literacy in the classrooms. Workshops such as this one may educate teachers on how quantitative literacy topics can be integrated into a variety of classroom environments and give more teachers the tools to explore quantitative areas of their subject matter.

In designing the quantitative literacy unit for this continuing education course, some of the existing barriers to curriculum change were considered and designed into the program. The course stressed the importance of quantitative literacy in both the participants' fields and in helping students to become quantitatively literate for a greater understanding of their subjects. Outcomes in secondary education can seem like a moving target to educators, but links to how quantitative literacy supports current educational initiatives and standards (such as the Next Generation Science Standards and the Common Core State Standards) may decrease the barrier to integrating quantitative topics into the classroom. Additionally, showing links to quantitative literacy in multiple courses may help to develop it as a habit of mind, both for the teachers and the students, allowing students to recognize that the exploration and understanding of numerical concepts is not limited to mathematics courses, but pervasive in all aspects of life.

Continuing education for high school teachers may foster the growth of quantitative literacy in secondary education. The model presented here demonstrates that a five-week continuing education program as part of a longer subject-specific program helped high school teachers in the natural sciences to learn about quantitative literacy, and for some, resulted in classroom changes to support quantitative literacy for their students. Although considered to be further afield from mathematics than the natural sciences, continuing education courses may be a way to support the growth of quantitative literacy education in other high school areas, such as social studies, the arts, business and personal finance, and increased use in technical courses. This pilot study may be useful as a framework on which to build additional experience in teacher education and promote the fostering of quantitative literacy in secondary education.

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