Social Interactions in an Online Environment: Developing Mathematical Process Standards

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Introduction

Teaching and learning in an online environment is a new delivery method when compared to the instructions methods that have been in place for decades. In fact, for many students, your online math class might be their first course they have ever taken online. Compare this to the hundreds of classes that they have had face-to-face throughout their years in K-12 classes. Even if you are teaching your course in a blended, or hybrid, method or completely face-to-face with online activities, students rarely have experience in this form of instruction. Experience is lacking even more so for an instructor who has not had the opportunity to take, let alone teach, online mathematical instruction. Preparing lesson plans and instruction in an online environment takes intentional thought upon not only what our students learn, but how they learn. One such way to develop lessons in online math classes is to focus not just upon the content to be learned, but also on the desired processes you want from students.

Matching Online Learning to Processes

John Dewey once stated, "If we teach today's students as we taught yesterday's, we rob them of tomorrow." Much of the current online mathematical instruction is centered around drill and practice with videos constituting the drill by replacing traditional lecture, and adaptive learning systems such as **A**ssessment and **LE**arning in **K**nowledge **S**paces (ALEKS) from McGraw-Hill or MyMathLab from Pearson invoking the practice with problem sets. While this method has its advantages with regards to time flexibility and instantaneous feedback, there exist some limitations as well. These limitations include a lack of assessment to the process standards set forth by NCTM. One such process is the ability to communicate mathematical thinking coherently and clearly to peers and teachers as referenced in the NCTM process standard of mathematics communication (NCTM, 2000). Traditionally, it is very common in online mathematics learning environments for student-student and student-teacher interactions to be minimal (Hawkins, Barbour, & Graham, 2012). Students end up working in isolation on math assignments away from the guidance of an instructor or fellow students limiting the social interaction skills which are vital to build meaning and permanence of ideas.

This isolation is magnified even further when it comes to student retention and struggling students. Limited student and teacher interactions are associated with increased student fear and anxiety, negatively impacting student motivation (Murphy & Rodríguez-Manzanares, 2008). Higher anxiety and lower motivation result in lower retention rates. Babson Survey Research Group (2013) found that academic leaders believe lower retention rates in online courses is a main barrier to the growth of online instruction. Therefore, it is theoretically possible that an increase of social interactions in an online mathematics classroom will not only help with improving and assessing student communication, but also reduce the amount of anxiety and fear students feel and thus improve retention rates in online courses.

Additionally, while drill and practice help many of our students learn procedural knowledge and algorithms, it fails to assess our students' learning of the conceptual understanding needed for proper communication. The focus of this lesson plan was built around the process of communication for Foundations for Algebra, an undergraduate developmental math course, with the intent purpose of increasing the potential for social interactions. Finding ways to add social interaction in an online mathematics environment is still a new concept.

Planning the Lesson

This online lesson was intentionally designed to be utilized in a variety of undergraduate mathematics courses with differing content. Meaning, the outcomes would be focused upon targeted mathematical process of communication rather than teaching to one particular area of study or course. The advantage of this approach is that the lesson plan can be adaptable to many different content topics (from adding and subtracting fractions in developmental math to the chain rule formula in Calculus). As well, the lesson would focus on authentic learning situations outside of a classroom environment.

Procedural Knowledge

How can we better prepare our students to learn outside of the academic environment and to help with transfer of knowledge? Many people access Google, and more particularly YouTube, for quick recall of knowledge – and in a much more authentic manner of learning, students share content over social media websites. Learning to improve this form of communication and dissemination of information will help our students in transferring mathematics into their everyday life. Helping students to better understand how to find and search the never-ending library of resources on procedural knowledge is an extremely helpful process and provides a foundation for becoming an intelligent consumer of mathematics.

Lesson Plan

The lesson content chosen was upon the addition and subtraction of fractions in an undergraduate remedial math course, Foundations for Algebra. However, as mentioned previously, the specific topic is not as important as the manner in which students engaged with the content, which was developed to attend to the mathematical process standard of communication. Therefore, the activity can be replicable into any online mathematics instructional course. There were three major activities positioned to take the place of traditional instruction, (a) Video Reflections, (b) Finding and Sharing Content, and (c) Rating Videos. Because the focus of the lesson was on the process standard of communication necessary for students to learn this material, the level of practice problems was reduced. These lessons were distributed to students through Canvas, the Learning Management System (LMS) at the university but could easily be added into any LMS at any institution. The format of the lesson instruction is demonstrated in Figure 1.

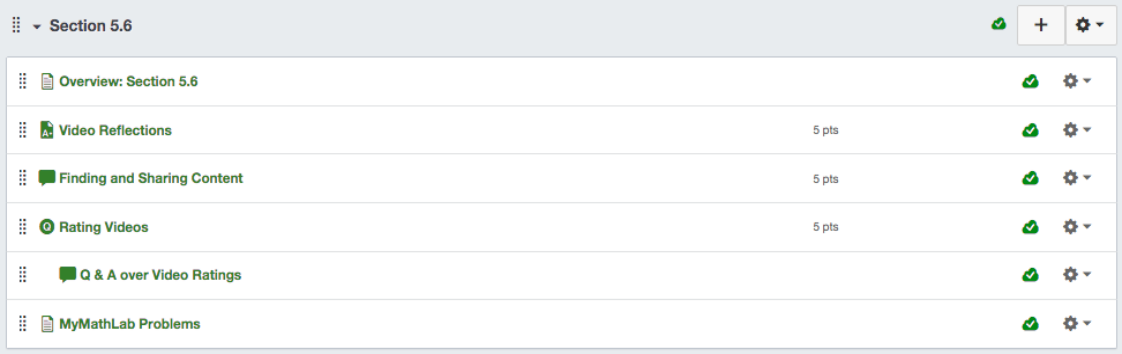

Figure 1. Module Overview of Lesson.

Activities Overview

The purpose of the Activity Overview is to help students understand how to research and review math videos. The objective is that through watching and critiquing the videos, students will gain greater insight and better understanding into adding and subtracting fractions. Because students will not always have the opportunity to have a math instructor teaching them the information, having them determine and communicate what is valuable from will help them become a better consumer of knowledge. These activities include:

- *Video Reflection:* Students will watch a few videos and then compare and contrast the validity and usefulness of the videos.
- *Finding and Sharing Content:* Students will find a video from a given topic in order to share with others.
- *Rating Videos:* Students will watch a few videos and rate the quality of the video and discuss the strengths and weaknesses of these videos.

- *Q & A over Video Ratings:* Students will have a forum to discuss the videos they just rated with one another, to ask questions and help with conceptual understanding.

- *Problems:* The students will then log into MyMathLab to practice some of the problems learned in section 5.6.

The following are more in-depth descriptions of the activities, their objectives and purpose.

Activity: Video Reflection

Sometimes you need a refresher of a skill or understanding of a concept. In order to figure it out, you go to the internet to find a video. However, there are so many choices out there with different ways of explaining, this process can be quite confusing. In order to help students better prepare for this learning and to improve one-on-one communication with the instructor, they will watch three movies and answer a few questions that will allow the instructor to gauge student conceptual understanding of adding and subtracting fractions.

Video 1 (figure 2) is a refresher video of how to add and subtract fractions, but it does not help a student know what to do when the denominators are different values. Students are given the hypothetical situation that when searching for a video to help them in adding and subtracting fractions with differing denominators they come across videos 2 (figure 3) and 3 (figure 4), and they then must answer the questions below.

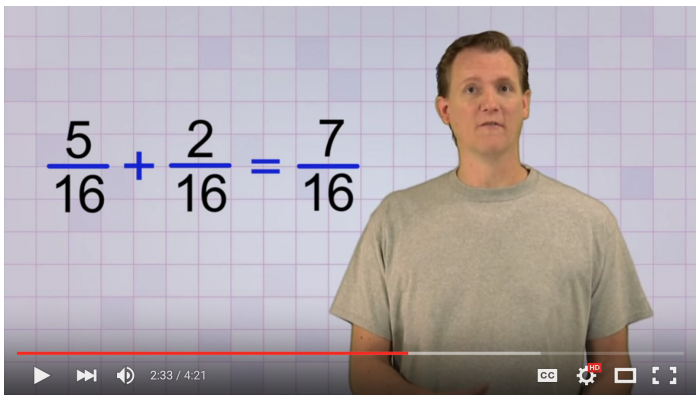

Figure 2. Math Antics – Adding and Subtracting Fractions.

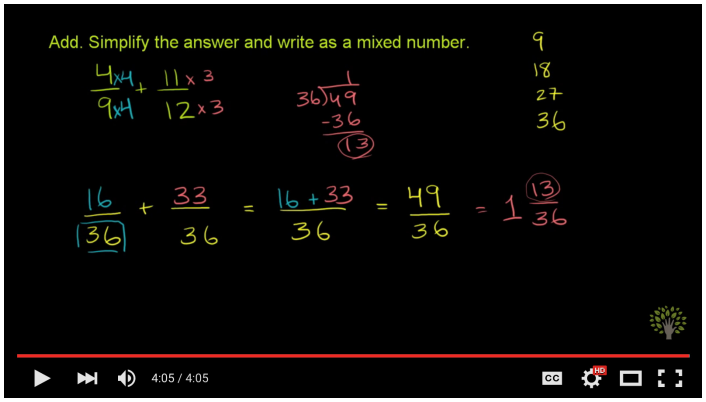

Figure 3. Easy Way To Add and Subtract Fractions.

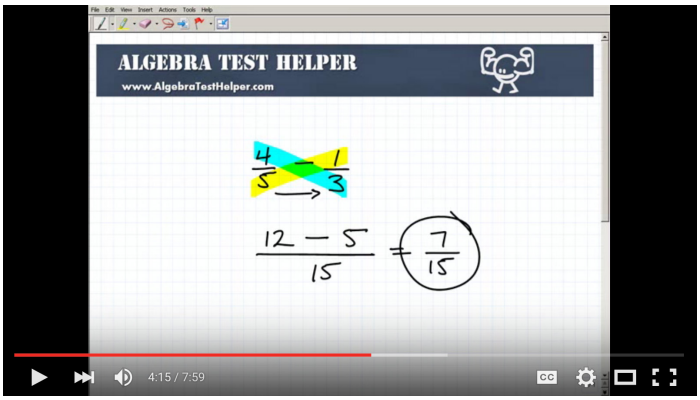

Figure 4. How to Add Fractions That Have Different Denominators.

Students are then prepped with the following prompt and questions to spark reflection on the videos they have just watched and to discuss some of the conceptual understanding:

> "Imagine you are walking in a tourist location and you stumble across a sign that says: 'Shortcut - Get To Your Destination Quicker This Way' - would you take it? Regardless of how you answered that question, if you were able to see a map and learn ***how*** the shortcut would save you time in context with the rest of the trip you could piece together a better understanding of the area. Learning a math concept is much like touring a new destination - the more you understand the big picture the easier it is to get where you want to go.

After watching these three videos please answer the following 2 questions:

1) Why does the Bow Tie Shortcut in Video 3 work? (hint: think about what you are multiplying to the first fraction and what are you multiplying to the second fraction)

2) Is the Bow Tie Shortcut the best choice every time? (hint: what happens when you try to do it with the problem in Video 2)."

This reflection allows for the instructor to see if they are understanding the bigger

picture of adding and subtracting fractions or at least the ability of the student to communicate those thoughts. Appropriate feedback and correction can be offered as the instructor sees fit.

Activity: Finding and Sharing Content

The next activity focuses on students finding and sharing video content with each other. Students are told they are given a problem to which they have to add or subtract a fraction (but the fraction contains variables) and you can't quite remember how to do it. One such problem could be the following: . Students are then told to go find a video that helps them explain how to add/subtract this problem. They are encouraged to find a video that they feel comfortable explaining the steps to someone else. This allows for students with differing skills and abilities to share a video that is specific to their current learning.

Next, students will be asked to share their video in the discussion board in the LMS. Then, they will respond to three other videos with one thing you like about the video and one thing you think the video could improve. This helps them communicate some of the ideas and concepts with their peers and provide opportunities for social interaction.

Activity: Rating Videos

In this activity, students are given two videos then are asked to (a) rate the videos and then (b) mention what they view as strengths and weaknesses. Figure 5 and figure 6 demonstrate two such videos that discuss other learning objectives necessary for adding and subtracting fractions. A discussion board allows the students to ask questions regarding the videos and the survey information is collected and then the results are shared with the rest of the class.

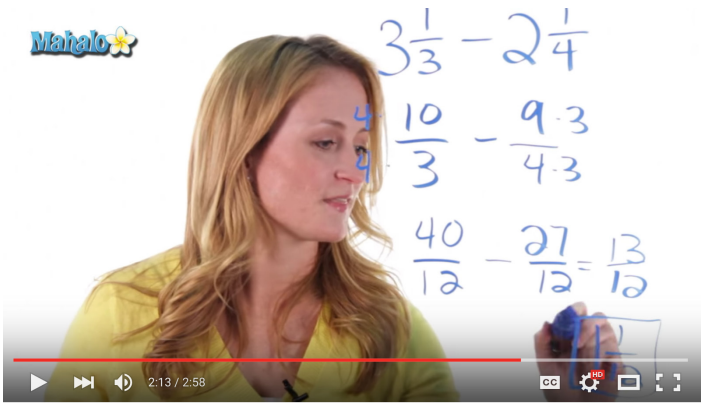

Figure 5. How to Add or Subtract Mixed Numbers.

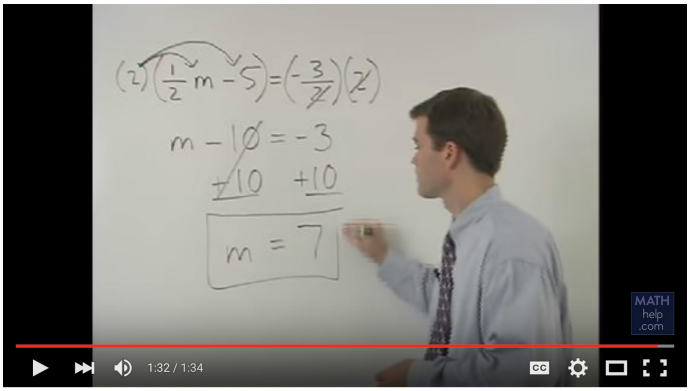

Figure 6. Solving Equations with Fractions.

Activity: MyMathLab Problems

Students will then solve a few problems using the MyMathLab to also show procedural knowledge and verify performance. An instructor can choose how many problems they feel will demonstrate mastery, but it should be noted that with the other social activities the amount of work required should be lowered from a traditional drill and practice style learning environment. Not many problems are necessary to demonstrate a mastery of a concept, and the video viewing has helped with multiple views of the same types of problems.

Students Participation in the Activities

Video Reflections

There are benefits behind student communication and feedback from an instructor to verify conceptual understanding. In the first activity of Video Reflections the students were to reflect upon the videos and submit their personal response that would only be seen by the instructor. The purpose of the activity was to introduce an alternative algorithm and encourage students to start discovering some of the issues that come from seeing multiple ways to solve one problem.

The two questions answered by students allowed the instructor to assess two NCTM processes. First, are students making connections between two videos demonstrating different algorithms? Second, are the student able to communicate when there were moments to implement different algorithms or shortcuts to the instructor? Measuring connections and communication is challenging, if students only perform drill and practice problems in an online environment.

Some of the answers from students on the first question demonstrated a deeper understanding of the subject and ability to make connections as demonstrated by Jenny who stated, “The reason it works because to come up with a least common denominator you have to times the numerator by the other fractions denominator. Whatever you

multiply the denominator by to get the LCD you need to do to the numerator and that is why you multiply diagonally." However, another student, Amelia, answered the question by including, "You are cross multiplying the number to get the number you need." This learning activity helps involve the instructor as part of the learning and can help address issues in comprehension with students who are struggling with conceptual knowledge. Amelia is confusing two different concepts and shortcuts, because she is finding memorization strategies (when two fractions are next to each other one must "cross multiply"). These questions are asked without a student needing to feel social pressure of how other students will view their responses, because only the instructor will see these responses and can address them appropriately. The teacher can begin a dialogue of communicating this mathematical concept with students who are struggling like Amelia and reinforce the conceptual knowledge of students like Jenny.

Communication was also taking place in helping students to mathematically prove why one shortcut algorithm worked. A good demonstration of what the instructor should be looking for came from one student, Anna, who stated: "If you used the Bow Tie method on this problem you would be dealing with very large numbers. By multiplying 18 X 24 you would have a denominator of 432. You would have a lot of simplifying to do. For this problem it would be easier to use the common denominator of 72. The Bow Tie method would work but would be harder to use."

Finding and Sharing Content

The expectation desired through the activity is to provide an opportunity for students to communicate their ideas and thoughts with fellow students. Part of the objective is to make them realize that all videos are not created equal (especially when it comes to determining how to solve a problem). Also, by having them view a variety of videos, they will better understand some of procedural knowledge. One such interaction among students and the instructor can be seen in Figure 7.

Rating Videos

This activity was designed for students to give their feedback, and then the data collected can be used to further a discussion on the topic of videos for learning. Figure 3 shows the results of two video ratings performed in the class with the different percentages. One interesting point was that each of these video assignments were from more difficult learning objectives with the last videos analyzing content that had adding and subtracting fractions with different denominators. Therefore, all the content that students needed to meet content outcomes were covered throughout the activities that focused upon learning process standards.

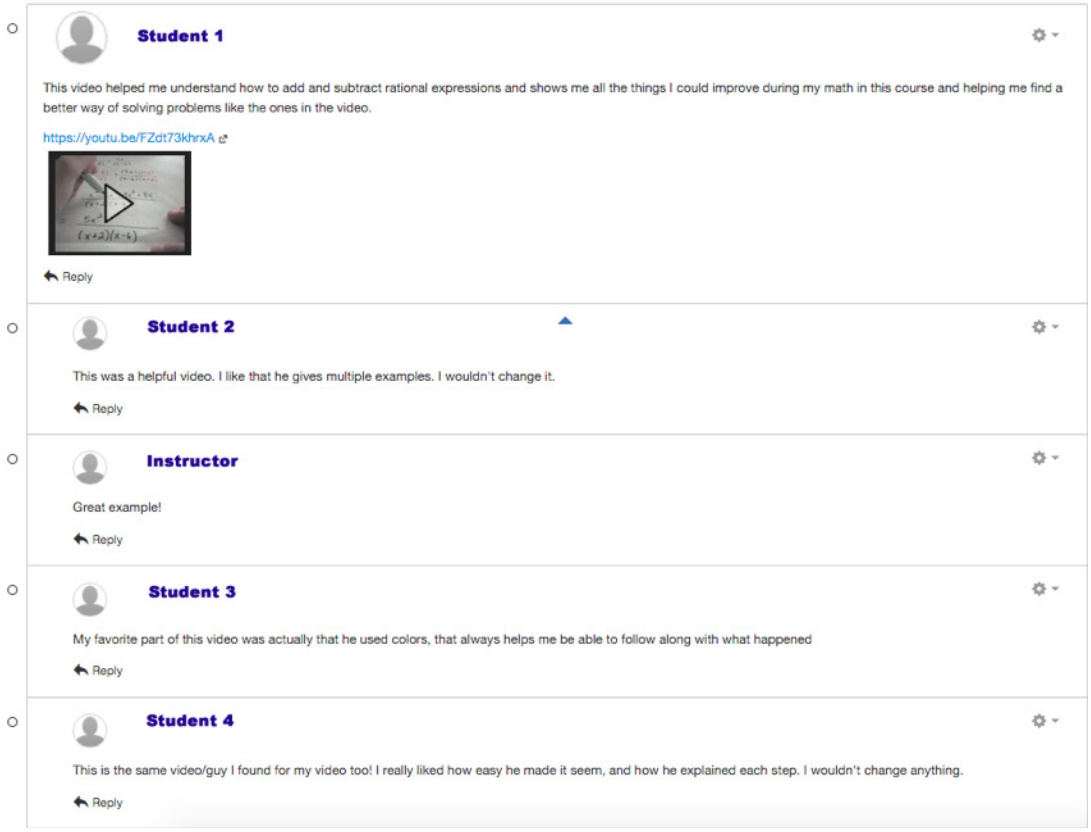

Figure 7. Example of Video Discussion.

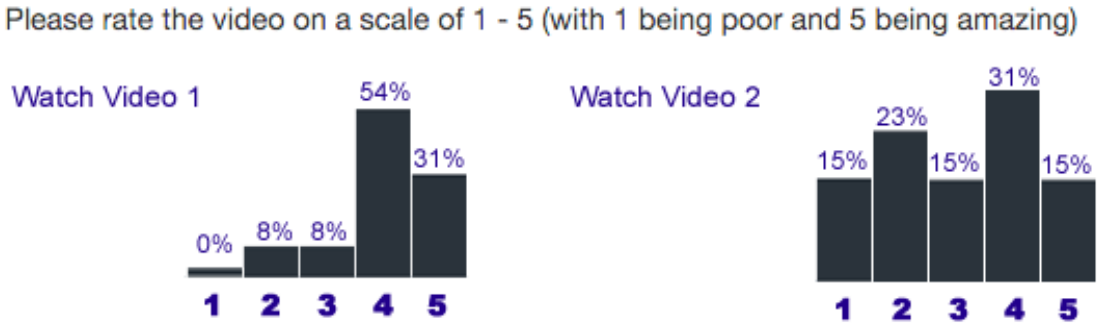

Figure 8. Results of Video Ratings.

Issues with Delivery

There were a few issues that were noticed through the enactment of these online math lessons which will help improve the quality of the lesson in future implementations. First, the completion rate was low among the students in these assignments which could be contributed to a number of factors. One potential factor was student course expectations had already been developed to work individually for more than eight weeks, and so changing assignment expectations that required student behavior changes made participation more challenging. On future implementations of this lesson, it is suggested that the instructor introduce the instruction of process standards earlier in the course and build social interaction opportunities with other such activities

at the beginning rather than introducing these activities in the middle of the semester when habits have been formed.

Another issue was that the asynchronous discussion sessions tended to have initial posts without much further discussion. Future implementation of this activity could focus on deepening the clear expectations and rationale through instructions and reminders from the teacher. Alternatively, you could have two to three required sets of feedback staggered over a period to time to allow time for the discussion to unfold in a more authentic manner. As well, this activity could potentially take place synchronously with an emphasis placed upon coming to consensus among the students.

Conclusion

In trying to improve the quality of learning and strategies implemented by math teachers in an online environment, it is important that lesson outcomes focus upon the desired behavior as well as content knowledge and procedural understanding. Implementing activities that encourage social activity of student-student and student-teacher will have the power to help an instructor assess content knowledge of students. In addition, the instruction will be able to measure student communication skills with the instructor and other students to give appropriate feedback as desired.

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