DISCUSSION TOPICS THAT MAKE ONLINE COURSES INTERACTIVE WHILE ASSESSING

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Abstract. How could we keep the conversation going (or even start it!) while teaching fully online, asynchronous courses and hybrid courses? While in class, for traditional courses, an instructor will assign individual or group work and ask students to record their results, but it will be very hard, if not impossible, to get all the conversation! For online courses the Discussion Board could be the best tool for doing that, if used the right way at the right moment. Finding the right topic that will keep students interested is very important! Tell them what you want from them, while giving them the freedom to decide what they want to say and how they want to present it. Make sure they are on the right track and see if they understand the concepts the topics are related to, while giving them the chance to make it personal. Be part of the discussion without embarrassing, but giving feedback that will help their learning process. Make students part of the process by asking their opinion and ideas on how to make a topic more interesting or interactive. Encourage peer assessment and reflections. In this paper I will introduce some general ideas that could be transformed in interactive and exciting discussion topics for statistics and mathematical modeling courses and I will share my results over time in both online and hybrid sections of Elementary Statistics and Introduction to Mathematical Modeling sections I taught.

Introduction

Located in Central Georgia, Georgia College & State University (GCSU) is the state's only public liberal arts college and the home of approximately 5,500 undergraduate students and about 1,200 graduate students. The Department of Mathematics offers a BS in Mathematics with an optional teaching concentration and has about 90-100 declared math major students guided by 15 full-time faculty. As essential for a liberal arts education, mathematics is considered an important area for our student, therefore, at GCSU each student must complete at least one three-credit hour course in Area A2 – Quantitative Skills of our core curriculum, while most of the majors, both science and non-science, require the completion of the three-credit hour Elementary Statistics course as part of Area D – Natural Sciences, Math, and Technology of the core.

Online and Hybrid Courses I Teach

As part of Area A2 – Quantitative Skills, the Mathematics Department at GCSU offers two categories of math courses: application-based and computational. The two offered application-based courses are MATH 1001 Quantitative Skills and Reasoning and MATH 1101 Introduction to Mathematical Modeling and they target especially non-science

majors, including nursing and business majors. As from Fall 2015 I was in charged of re-designing and teaching all sections of The Introduction to Mathematical Modeling course as a hybrid after being part of the team who re-introduced the College Algebra course using the Emporium Model [5] in Fall 2011.

In Summer 2013 I was the first faculty in our department who designed and taught an online Statistics course that became very popular – we had 75 students who signed up for the online section that summer and since then other courses like College Algebra, Introduction to Mathematical Modeling were offered online during summer. After COVID-19 pandemic, when online components became very important for all our courses, during summer terms our department offers only online sections for most core courses, the most popular being the statistics course with 6-7 sections each summer, each having about 30 registered students each. Currently, most of our courses, including the traditional ones, have at least an online component.

Online Statistics Course Evolution

When I started teaching online, I tied to design my asynchronous eight-week course so that I will be able to interact with my students not just by email, but also discussing the materials they were assigned. In a traditional class I always let my students work alone or, most of the time, in groups and at the end of the class I ask them to share with the entire class their results. I am always fascinated by the amazing learning environment created during such activities, when, even if many students declare they do not like math, they like to be right or race to correct their mistakes when pointed out. I am able to learn a lot about how much they understood from that topic or their misunderstandings just walking around, listening, or asking simple questions related to the activity I assigned. Therefore, I was looking for something that will feel like that in an online class and discussion board was one option I considered from the beginning.

For the first time I taught the online Statistic course the discussions were part of the grade, but not all were required. Students had to post at least four main threads and comment on some of their classmates' posts. That summer I realized that keeping the students interested and involved in the learning process is very important and the discussion topic would make a big difference in this process. Since then I made many changes to my online course and I will always be looking for ways to improve the online learning environment.

Homework	Quizzes	Final Project	Online discussions	Test 1	Test 2	Total
10%	15%	30%	15%	15%	15%	100%

Figure 1: Grading Policy Online Stat

The above table of Figure 1 shows my most recent grading policy for my online summer statistics course. The discussions weight is 15% now, compared to the 5% when I started back in 2013.

Hybrid Course Evolution

After redesigning the Introduction to Mathematical Modeling course using the Emporium Model, even if my students' results were pretty good, while the WF rates went down, I started realizing, especially reading my students' answers to my surveys, that something was missing. Even if the class is flipped, and students are participating in group activities during our 75 minutes weekly face-to-face meeting, out of class, according to the Emporium Model rules [4], they spent most of their time in the Math Emporium Lab, working on their homework assignment, relying on the help they received from the tutors, but not really understanding what I wanted them to understand. While following the Emporium Model [5] my grading policy followed the table in Figure 2 below.

Weight	Homework	Reading Quizzes	Quizzes	Tests	Final Project	Total
Item	15%	15%	15%	30%	25%	100%
Details	Syllabus Quiz and 11 assignments in MML	11 quizzes in Georgia View	11 Quizzes in MML	3 tests (10% each)	5% for first draft 20% for final project submission	
	lowest 2 scores will be dropped	lowest 2 scores will be dropped	lowest 2 scores will be dropped			

Figure 2: Grading Policy - Emporium Model

I just realized that my application-based course, which was supposed to show students the connections of the mathematics they learned already with the real life, became more or less a computational course – just solve a bunch of problems and try to learn the methods. In Fall 2021 I decided to stop using the Pearson platform and I created my own course materials using our GeorgiaView (Brightspace/D2L) platform. I believe that asking students to participate in discussions on topics that require them to review and use the material covered in each of the ten modules I created for them will help me better assess their understanding, while getting to the main learning objectives of this application-based course. Afterall, applying "strategies that matter" [7] should be each instructor's main goal! The table in Figure 3 below shows my most recent grading policy for this hybrid course.

Module Discussions	Participation	Reading Quizzes	Quizzes	Group work	Tests & Projects	Final Project	Total
10%	4%	10%	15%	10%	36%	15%	100%

Figure 3: Grading Policy - new design

All my classes are organized in modules that are grouped in units. My online courses have usually two units, each having four to five modules. Each unit is assessed with three quizzes, three discussion topics, and a unit test. Only one discussion grade will be dropped at the end of the term. My hybrid course has three units containing a total of ten

modules, each module assessed by a quiz and a discussion topic, students being required to participate in at least eight discussions for a chance of receiving the 10%.

Discussion Topics

Since I started teaching online I was continuously looking for topics that will make the discussions interesting while giving me the chance of assessing students' understanding of major concepts covered in class. Some topics will require my students to do a little research, or conduct a little experiment, and some time just to reflect on some problems from their assignments. According to Barkley and Howel Major, we should never stop identifying ways of improving results of even successful tools by being prepared "to determine if adjustments could and should be made at different stages" [1] based on our results.

My first topic, in all my classes, is the Introduction Discussion, where each student is asked to introduce themselves and write about their interests. Based on what they write in the Introduction, I try to choose topics that will relate to as many of them as possible, or make changes that will make a topic accessible and interesting to most of them. Some time I change the requirements if I see little interest or struggle. This first discussion is required and students can't participate in any other discussion without posting in the Introduction, leading to loosing 10 to 15% of their grade.

Each discussion topic starts with a general idea that could change based on the input and feedback I receive from students. The main goal of all these discussions is to help students to observe, understand and make connections between mathematics and real life. Each module has its topic or a list of topics students could choose from. Students get instructions about their main thread and their comments on other posts and for most cases they have an example of what I expect to see included in the instructions file. Students are allowed to make corrections in new posts and receive bonus points, even after deadline. As I want them to be original and complete the assignment in their own way, I don't allow them to see other threads until they post their own.

Over time I changed my assignment so that they will be more "relevant, collaborative, and transparent" [7], giving more detailed instructions, and most of the cases an example that students can considered before creating their thread or comment. Here is an example of some change in the discussion topic covering the first module of my Introduction to Mathematical Modeling online course, covering relations, functions, and linear functions.

The first topic I used for an online section was introduced as:

> *In this first module you learned about the simplest and easiest to work with function - the linear function. You were also able to see many applications of this function, most of them real life applications. Think about how you can apply linear functions in your life and come up with a problem that can be modeled into such a function. Make sure you explain what are the two variables, which one is the independent and which is the dependent, what is the rate of change and how it will affect your function.*

Comments on other two posts by considering an example for a particular value that will make the problem either imposable or an excellent fit considering the actual possible domain for the respective function.

The topic of the discussion for my Linear Function Module in my hybrid course is presented as:

In this module you learned about the simplest and easiest to work with function - the linear function. You were also able to see many applications of this function, most of them real life applications. Think about how you can apply linear functions in your life and come up with a problem that can be modeled into such a function. Make sure you explain

- *what are the two variables?*
- *which one is the independent and which is the dependent?*
- *what is the rate of change and how it will affect your function?*
- *write the equation*

Comments on other post by considering an example for a particular value that will make the problem either imposable or an excellent fit considering the actual possible domain for the respective function.

Another topic that I changed over time, in my hope I will make it more personal, but also interactive, while covering all important properties covers the module on the quadratic function and its applications. The old topic was too broad and general while the new one makes it more personal. Therefore, I changed it from:

As kids you played with a ball or threw a rock toward an object. For most of these situations, if you look at the trajectory of the object it is a parabola, or a part of a parabola.
Try to do an experiment like this or anything else you can think of that can be modeled using a quadratic function and explain in your post what you did, what you used, and what type of parabola you will use for you model. Also mention the variables you considered, like what is the independent variable and what is the dependent one.
You can also search the net and look for a quadratic model to discuss. Don't forget to mention the source if you did not do the experiment yourself.
Comment on another post comparing their type of parabola to yours

To this:

Suppose you are on top of a 30 feet high building and want to throw a ball upward. Consider the following scenario:
You jump throwing the ball when you are 2 feet in the air, the ball leaving your hands from the top of your head level, at a speed of 70 feet per second. Suppose the height of the ball can be modeled by $H(t) = h_0 + 70t - 16t^2$ *feet, where* h_0 *is the initial height of the ball (the height when it leaves your hands). Do the following: (See the example I prepared for you with my case!)*

- *Find h_0 by putting together the height of the building, the 2 feet jump and your height in feet.*
- *Write the function for your personal case*
- *Find the maximum height of the ball for your particular case and the time needed to get there.*
- *Find the time needed for the ball to reach the ground.*
- *If a person who is 5.9 feet tall could reach up to 7.7 feet to catch the ball, will it be possible for that person to catch it after 4.5 seconds?*
- *What about 4.8 seconds?*

Comment on at least one other post after checking how long it will take for you to catch their ball before reaching the ground

My case example of thread:
My height is 64 inches, that is about 5.3 feet. Therefore, $h_0 = 30+2+5.3 = 37.3$
The height of the ball will be model by $H(t) = 37.3 + 70t – 16t^2$ feet.
In my case, the ball will reach a maximum height of about 113.9 feet in about 2.2 seconds and the ball will reach the ground in about 4.86 seconds.
In 4.5 seconds, the ball will be at 28.3 feet above the ground, so a 5.9 feet tall person will not be able to catch it in the air, but in 4.8 seconds will be at 4.66 feet above the ground, so any person reaching more should be able to catch it.

Another personalized topic that is very popular and has always a very good participation especially in the comments area is related to the investments and annuity module. Students are engaging very easily with this topic and make very interesting and pertinent comments. The instructions for this are given below:

For this topic, I want you to use what you learned in Module 10 to look at a possible action: buying a new car. Think about the car you would like to have and were you may get it (most likely a dealership!) Research online the selling price but also the interest rates and choose one that is convenient for you (suppose you can't get 0% for that car). Find, using the formulas you learned how much would you have to pay monthly in the period the dealer offers you and how much over the selling price will you end up paying at the end of the lease. Consider the final cost of the car will include sales tax and, possible dealer's fee.
Post all those results in the discussion board together with all the other information: car model and maker, interest rate, selling price, term of lease, and everything else related to your story.

For the comments to the other classmates posting try to give suggestions for a better offer related to their story.

And, finally, one more example from my online statistics course discussion forum:

In Chapter 8, A8, you learned that the size of the sample is very important when we do inference. Think about an experiment that one can conduct on a small sample versus a large one and the implications it can have when inference is used. Think about sport, pharmaceutical industry, politics, or any other domain. What else than the size will also be important for a sample to conduct to reliable inference?

For some modules, where we cover multiple models in Introduction to Mathematical Modeling, I offer choices by letting my students choose from three or more ideas and asking them to comment on threads that cover a different topic than they chose. For my probability module in Statistics I ask students to come up with an experiment and create their own probability problem, while other students will try and solve that problem.

Assessment and Feedback

The discussions are graded with a rubric that gives general feedback but allows me to add personalized feedback when I see it fit. In all my classes I chose to follow the three principles of effective moderating that Collinson, Elbaum, Haaying, and Tinker mentioned in their book [3], and the one that I considered the most important is Principle two: "The Style of "Guide on the Side" (vs. "Sage on the Stage") is Most Appropriate for Leading a Virtual Learning Community" [3]. I do not engage in discussions but monitor them and try to correct mistakes giving individual and not public feedback. When students have excellent threads, I do not praise them by replying to their post, but in the feedback that I give while grading the discussion. When they make mistakes I also give them feedback in the rubric and point them in the right direction. Students are allowed to resubmit a new thread if they want partial credit, as long as the discussion is still open.

The late submissions are allowed, but students will lose points if they do not post their main thread before the deadline. I also try to be very explicit with what I want them to say when they reply to their classmates' posts. For examples, if they do not follow my instructions and reply with general comments without any connection to the topic or not explicit connection, like: "Great example!", "I really liked the example problem you used. I also felt like you did a great job explaining your problem as well. Great job!", "Very organized example!", or "Your example really helped me understand the concept better", they will only receive one point out of the three reserved for the reply/comment section in the rubric. As Palloff and Pratt, I believe that "The assessment of students assignments in an online course should not be the job of the instructor alone." [6], therefore I would like student's reply to other posts to be more like a peer evaluation.

Figure 4 below shows my old rubric that I used to grade my online courses discussion topics, while Figure 5 shows my current rubric, used for both my online and hybrid courses. As I mentioned above, each rubric allows me to give personalized feedback when needed. Therefore, students will be able to see their grade for the main thread and for the replies, see why they receive that grade, and, my praise if they did an excellent job, or my hints on how to improve their posts in the future or re-submit for partial credit.

Students have access to the rubric before I use it and they are aware of it from the beginning of the class. I mention and discuss the rubric in my detailed syllabus and I link it to my Orientation folder and to each instruction file I prepare for each discussion.

Discussion Board Rubric

Course: Intro to Mathematical Modeling Section W01 Summer 2017 CO

Criteria	Level 3 2 points	Level 2 1.5 points	Level 1 1 point	Level 0 0 points	Criterion Score
Initial Discussion Post - Readings	Thoughtful processing of assigned readings. Includes references to the text, but goes beyond to construct personal meaning. Responds thoroughly to prompt, if given	Summarizes readings and includes several key points. May include personal experiences. Addresses prompt, if given.	Brief or inappropriate posting. May give very general response to prompt, if given.	No posting.	/ 2
Initial Discussion Post - Experience	Makes rich connections to field-based experiences. Explores the meaning of assigned readings or course experiences for teaching practice and student learning outcomes in content area teaching.	Reports ideas for future teaching.	Makes general or vague connections to experiences.	No posting	/ 2
Responses to Posts	Responds to two (2) colleagues' blogs. Responses are meaningful, appropriate, and supportive.	May respond to only one colleague or may offer very brief, vague or general responses.	Does not respond to colleagues in timely manner.	Does not respond to colleagues at all	/ 2

Total / 6

Figure 4 Discussion Rubric-old

Module Discussion

Course: Intro to Mathematical Modeling Section 03 Spring 2023 CO

Criteria	Level 4 7 points	Level 3 5 points	Level 2 3 points	Level 1 1 point	Level 0 0 points	Criterion Score
Main Thread post	All requested parts were answered	Most of the parts were answered, but important ideas are missing	Less than half of parts were answered, but the answers were correct	something was posted but does not address the topic	No post	/ 7

Criteria	Level 3 3 points	Level 2 2 points	Level 1 1 point	Level 0 0 points	Criterion Score
comment on another post	comment with the required information	the comment only touches some of the required information/ has errors	General comment (nice, great, etc)	no comment	/ 3

Total / 10

Figure 5 Discussion Rubric-new

Participating in discussions is mandatory for my courses, as the discussion is part of the course grade, but I drop one or two lowest grades at the end of the semester, allowing students to miss a discussion or two without consequences. The table in the Figure 6 shows a statistics of student participation in discussion board topics during Summer 2022 online Statistics course, over the six discussion topics, and Spring and Fall 2022 semesters for my hybrid Introduction to Mathematical Modeling sections over the ten discussion topics.

	Total students	Total Threads	Total Replies	Average Read (including own)	No participation (average)
Summer (6)	23	114	211	50	4/topic
Fall (10)	67	549	424	60	5/topic
Spring (10)	50	363	318	42	6/topic

Figure 6: Discussion Participation

Conclusions: What Students Learned

Working with non-science majors in a math course is most of the time a challenge and requires more preparation than for math courses where students either like mathematics, or, at least, they know they will need it later in their major's course work. Most of my students, when asked, will say that they "hate" mathematics and they do not believe they will ever use it after their course. Students in these areas, like arts, nursing, psychology, literature, and many others that include, surprisingly, business, think that the mathematics courses they need to take in college are just useless requirements that have nothing to do with real world, where they need to memorize and use lots of formula that have no real application and all concepts are hard to understand. Throughout activities like the discussions I use in my courses, students get to see the benefits of knowing and, most of all, understanding a bit of how close mathematics is to real world. They use mathematics in problems that are related to them or those they know and get to apply what they learned in class in different ways almost everywhere. They may even get to realize that real life relies a lot on math or just mathematical thinking and mathematics is not just useful but could also be fun.

Conclusions: What I Learned

I had never believed that there are people who can not learn mathematics, but I always knew people learn in different ways and each person has their own capacity of learning a subject or another. Therefore, for some, learning and understanding mathematics may be a bigger challenge than for others. What I learned since I started teaching mathematics is that the most important factor in bringing students to the table in the learning process is motivating them. Finding that motivation is the key and there is no standard way of doing that, since each individual is unique. One thing that works very well in my case was

asking students for feedback and using that feedback. Challenging students to come up with ideas about how to apply what they learned will lead to finding topics that will be well received and exciting, like the ones involving money, investments, paying out debts, planning on trips, and many other examples. I use what Bronwell and Eison call "Student-Generated Questions" [2] to create new topics. Analogies of mathematical facts with real life facts helps students remember – challenge them to look for such analogies instead of asking to memorize definitions or formulas. Students are taking assignments more seriously if they are in charge and they even correct each other, being part of the assessment if they are leaded toward the right direction. Students will participate more in online discussions because they don't feel like in a spotlight, especially when I do not play a main role in the discussion but just moderate it in the background, making sure they stay on track.

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