

DISCUSSING MATHEMATICS ONLINE

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Using online discussion forums provide opportunities for interaction between students, between the student and the instructor, and between the student and the course material. Online discussions can be effectively used in traditional face-to-face classes as well as in hybrid and online courses. While course management systems, whether open source such as Moodle, publisher-based such as MyMathLab, or college-purchased such as Blackboard, provide discussion boards but instant messenger programs such as AIM, email, and systems such as *Illuminate Live!* provide equally useful forums for discussion as well. Whether on a discussion board, a chat forum, or via email, for example, participation among course participants can be achieved.

Typing-based discussions using discussion boards, virtual chats, or email, for example, provide opportunities for using course terminology and for consideration of course concepts, methods, and ideas. Being able to understand and to use course terminology require practice. This practice can come in the form of concept discussions, considerations for applying methods and formulas, problem analysis, and project analysis and presentation. Concept discussions: for example, for statistics, *What is/are Statistics?*, for calculus, *What is a Derivative?*, or, for mathematics in general, *What is a Variable?*, are crucial to enabling students to understand the building-block ideas for a course or the discipline, in general. In addition, using demonstrations or interactive tools, students can explore concepts and discuss and contrast their findings online. Discussions for which method and formula application are considered provide opportunities to contemplate the conditions under which methods can and cannot be applied as well as the information required for using formulas. When multiple formulas are available, formula comparison discussions, for example, in statistics for the standard deviation or the linear correlation coefficient, provide opportunities to consider problems that may arise in using one formula over another like round-off and truncation and the ease use of the formula, and, for example, the rate of convergence of methods for determining the numerical solution for an equation or determining the numerical derivative or numerical integral in numerical analysis. Analysis of practice exercises provides an opportunity to apply course methods as well as to use course terminology in the presentation of the problem analysis and results. Finally, discussions involving the presentation of project analysis and results provide opportunities for student and instructor interaction regarding the application of course concepts and methods.

Depending on the environment used, online discussions cater to the different learning styles. The visual aspects of discussion forums, virtual chats, and email, for example, as well as the whiteboard and common browser functions available in *Illuminate Live!* and

virtual classroom environments available on Blackboard, for example, are beneficial to visual learners. The verbal discussions possible using forums such as *Illuminate Live!* are favorable for auditory learners. Online discussions are particularly advantageous for the kinesthetic learner since the group interaction, the working and doing together, even when asynchronous, provide necessary active learning. Especially important in the online discussion is the transcript which can serve as a record of the class or group work/interaction and a source of information for course notes. In addition, using the discussion transcript or recording, participants can review the discussion as well as reexamine the process of analysis and problem solving, reconsider the use of terminology and rethink their analysis and formulation of the problem.

While discussion questions can be used to perform knowledge-checks, the best discussion questions are designed to make connections and to target higher order thinking. Left to their own devices, students focus on a numerical value as an “answer” rather than on the formulation of the problem with its analysis, solution, and interpretation as *the answer*. Deep thinking about concepts helps the student to integrate new concepts and ideas with previous knowledge. Understanding how to interpret results and the information acquired through analysis helps the student to understand when concepts and methods can be applied.

A successful online discussion provides opportunities for the student to contribute her/his questions, explanations, and methods of solution and to test these against those of others. One of the most important problem-solving skills is inquiry. The formation and statement of questions is crucial to determining what information is known and what must be determined. Inquiry tests the base-understanding of the questioner while integrating newly acquired knowledge since the question must be posed. Through online interaction, alternate answers to questions and alternate explanations can be explored and shared. Online discussions provide a forum for sharing and testing alternate approaches for analysis solution determination, and interpretation. However, in this, the active involvement of the instructor is important since these alternate answers to questions, alternate explanations, and alternate approaches for analysis, solution and interpretation must be evaluated for correctness and usefulness. So, the active participation of the student and the instructor are important in this process.

For online discussions to be used effectively, the instructor must carefully consider the participants. Those contributing in the online environment must be self-motivated, diligent, and responsible. Especially for typing-based forums, the reading ability and writing ability of the participants must be considered. Those having poor reading comprehension take longer to process written information as well as to contribute to written discussions. For those with reading difficulties, the online environment should not be encouraged since this puts such a participant at a disadvantage.

The course atmosphere can either be a help or a hindrance to online discussions. An encouraging atmosphere in which questions and correction are welcomed while unfair judgments and disrespectful remarks are discouraged is crucial. Discussion participants

should feel welcome to ask questions, and they should not feel as if they are being judged: there is not such thing as a stupid question, and all questions are important to the integration and evaluation of new knowledge. Rules for online behavior, what I call my *Rules of Engagement*, are fundamental for creating a nurturing, learning-centered online environment. At all times, interaction, responses, and correction must be respectful and flaming, “the posting of hostile, offensive, threatening, insulting, or disrespectful materials online or the sending of hostile, offensive, threatening, insulting, or disrespectful materials by email or instant messenger” (this is directly from my *Rules of Engagement for Discussions and Communication*), must never be tolerated. At all times, each participant must consider how (s)he would feel if (s)he received the post or email that (s)he was planning to send – this makes the participant considerate of one another as well as mindful of the environment in which (s)he is a member. The instructor must create the necessary supportive learning environment, and this can only be done using direct statements regarding the behaviors that are correct in comparison to those that are unacceptable: positive behaviors must be encouraged while a consequence for unacceptable behaviors must be well defined. For my online discussions and communication, the consequence for offensive or inconsiderate emails or postings having a hostile/disrespectful tone and any instances/occurrences of flaming is the reporting of these, with all supporting documentation, to the Dean so that college policies and sanctions can be implemented/followed. Since many participants hide behind the anonymity that they find online, proper online behavior must be defined and unacceptable behavior must be discouraged.

In order to make discussions fair for all, the level of participation must be well-defined. I have found that requiring a minimum of a main posting, a first response (a non-frivolous comment, suggestion, or question posted in response to a main posting), and a second response (a non-frivolous comments, suggestion, or question posted in response to a first response) for each discussion forum provides a basic level of participation that most students continue. Emphasizing that postings must be non-frivolous is important and such postings must not be counted for forum participation or rewarded when grading. Participants must view their contributions as a way to share the learning process rather than a way in which to earn points. In addition, these postings provide a mechanism with which to test their understanding, to consider alternate questions, and to devise alternate explanations. On discussion forums, participants become partners in teaching and learning.

Key to creating a positive learning environment is the introductory course discussions and the forums provided for general questions. Using a *Meet me Online!* forum, participants have a opportunity to introduce themselves to other participants, sharing their experiences related to online learning and their experiences in learning mathematics. In addition, participants can discuss how their interests and experiences may be related to course topics. Since participants must be encouraged to try rather than to give up when they are having difficulty with their analysis, a *Give me a Hint* forum provides an opportunity for participants to seek help from others or the instructor; such a forum should be open to all for contributions and further questions. A *Sharing Student*

Questions with the Class forum can provide an outlet for questions that participants would like to ask anonymously; such a forum should be set up so that only the instructor can post so that all postings can be nonjudgmental and positive. The instructor must keep in mind that (s)he is responsible for the interaction between participants and well as her/his interaction with participants.

Concept exploration discussions can be used to provide a simple introduction to a concept as well as to integrate new concepts with those previously examined. In addition, they can be used to help participants to consider the importance and uses of concepts, methods, and ideas. For example, when considering variables, a *Do these make sense???* Discussion for exploration of statements vs. column headings for tables, vs. actual variables can be thought provoking as can a *Qualitative Variable???* *Quantitative Variable???* *Or Not a Variable at All???* discussion; for continuity, further discussion examples will be from introductory statistics. When considering sampling it can be helpful for participants to consider *Why is sampling important???* as well as to be able to recognize sample types, *What type of Sampling???*, and in order to understand what makes a good graph, a *Why is this graph misleading???* discussion can be used to compare graphs and to consider missing and misleading information provided in graphs. Being able to recognize key concepts and to discuss them is important and provides many opportunities for discussion such as *Binomial Experiment?*, *Probability Distribution???*, *Explanatory Variable vs. Response Variable*, and *Null Hypothesis and Alternative Hypothesis*. Considering the basic ideas as they are examined provides participants an opportunity to learn new terminology and gain an understanding of this terminology so that it can be used in discussions for analysis and interpretation. Examples of these include discussions of how to create simple random samples, stratified samples, and systematic samples, interpretation of the slope and y-intercept of the least squares regression line for bivariate analysis, determination and interpretation of a confidence interval, and hypothesis testing and the interpretation of the results. Using discussions to check analysis and use of formulas provides helpful practice for participants who struggle with using formulas. Such discussions are especially helpful in the examination of topics with which students have particular difficulty such as the calculation of the linear correlation coefficient, the determination of the least squares line, and the determination of the five-number summary, for example.

Open-ended discussions involving application of concepts and methods are particularly helpful when the participant can personalize her/his experience, for example, by selecting the data that (s)he examines. Such discussions help to make topics such as frequency distributions, relative frequency distributions, graphical analysis and interpretation more relevant and more interesting for both participants and the instructor.

The asynchronous aspect of online discussions provides the participant the opportunity to reflect on her/his postings as well as on the postings of others. The participant can reconsider her/his postings in comparison with the postings of others, evaluating and testing these postings using both previous and new knowledge. The evolution of the group's analysis in the discussion as well as the group problem-solving experience can

help participants to understand that analysis comes in parts and as a result of a variety of questions. Very important in this process is that participants can come to value inquiry as a useful tool in learning and exploration.

With all this said, it would be unfair not to point out that using online discussions is time consuming. Designing online discussion questions and defining the levels of participation as well as necessary restrictions and grading rubrics requires investment of considerable time. Testing and evaluating the wording of discussion questions for clarity is important as is consideration of possible responses and questions. Reading, evaluating, and replying to typing-based discussions requires time and patience. Since this is the participant's first use of new concepts, methods, analysis, and interpretations, correction must be preformed carefully and in an encouraging manner. The time investment is not on the instructor's side alone, participants invest time in reading, re-thinking, and re-evaluating their understanding of both new and old knowledge. While, overall, using online discussions may require the participant to make a greater time commitment in order to read, evaluate, consider, and synthesize her/his postings in light of those of others, this results in deep thinking and, for many, the elimination of the idea of learning as being a lonely endeavor.