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**Topic:** Teaching Quantitative Physiology using a Flipped Classroom Approach

**Resources:**

- Yuja – video integration with Canvas - <https://www.yuja.com/>
- Shared Textbooks:
  - Feher Quantitative Human Physiology (caveat: mostly algebraic thought): <https://www.sciencedirect.com/book/9780128008836/quantitative-human-physiology>
  - Khoo Physiological Control Systems with simulink examples: <https://www.wiley.com/en-us/Physiological+Control+Systems%3A+Analysis%2C+Simulation%2C+and+Estimation%2C+2nd+Edition-p-9781119058809>
  - A Comprehensive Physiologically-Based Approach to Modeling in Bioengineering and Life Sciences: <https://www.sciencedirect.com/book/9780128125182/a-comprehensive-physically-based-approach-to-modeling-in-bioengineering-and-life-sciences#:~:text=Description-A%20Comprehensive%20Physically%20Based%20Approach%20to%20Modeling%20in%20Bioengineering%20and,the%20conservation%20of%20mass%2C%20electric>
  - Linda Costanzo – good medical book that medical students use but doesn't have math in it: <https://www.elsevier.com/books/costanzo-physiology/mckenzie/978-0-323-79333-9>

**Presentation Overview:**

- Quantitative Physiology Learning Outcomes:
  - Understand structure, function of nervous and musculoskeletal systems
  - Apply engineering models to understand human physiology
- Flipped Classroom Approach:
  - No Live class Mondays, watch videos of lectures and take notes. Wednesday – take 10 question quiz and in class do small group exercises (replaces what was homework before). Friday – take survey prior to class to suggest topics and ask questions, review material similar to office hours
  - Assessment: video quizzes, flashcard quizzes, block quizzes, problem-based learning project, final exam – quizzes are frequent small low-pressure opportunities for learning to allow students to learn, make mistakes, and ask questions. Final exam is individual assessment to measure how much they learned but is similar to in class group exercises so attendance is best way to practice
- Lecture Videos
  - Uses power point and provide students with notes with skeleton version of slides, annotate the skeleton notes in real time as explaining content
  - Embedded in Canvas using Yuja – provides number of views, duration of playback, and date statistics – noticed that 90% of students watch video and watch it more than once as it allows students to rewatch content, and only drops to 85% of students viewing it by last video
- Online Quizzes
  - Comes from specifications grading concept, most pass/fail and get full credit as long as trying
  - Academic dishonesty is a concern, but there is no pressure as most students pass quizzes (99%), no reason why they shouldn't try it on their own
- Small Group Exercises
  - Block off every 3<sup>rd</sup> row so instructors can reach students without climbing over students, only possible if classroom is big enough and attendance not required
- Student Assessment of Effectiveness of Flipped Approach
  - Midquarter survey each year noted that lecture videos and skeleton lecture notes were highest rated techniques that helped students learn, also appreciated reviewing material from videos in class

- Video quizzes and flashcard quizzes also mentioned that they were helpful in learning material
- Small group exercises were not as perceived as useful, but data was taken during pandemic when course was offered online
- Instructor likes not having to repeat same lecture every year and can spend more time working on more difficult content and being more interactive with the students, canvas quiz autograding reduces amount of grading and allows instructor to instantly switch to remote teaching if needed

### Discussion:

- Linsey Moyer – how many videos watch? Each is 10-15 minutes and they watch a few during week (total 90 minutes a week).
- Tomas Gonzalez Fernandez (Lehigh University) – teaching it for first time, but doing it at grad level, wants to know about project component and how it is evaluated (model? Prototype? And how to provide feedback?)
  - Open-ended design project in teams of 4-5 students with a written report and video. Report does background on topic, and video does design challenge with a video on their solution (a conceptual design with flow chart) on a brain-computer interface design
  - Keep structure every year but change the design or problem that BCI needs to solve (e.g. last year was to apply BCI to creatively express selves with painting/photography/etc.) but main this is use EEG to control a machine
  - Beth doesn't like that as course goes on, project becomes more disconnected from class because brain physiology is only in beg
- Megan Griebel and Linsey Moyer – do they have any problem based homework or is all assessment just quizzes?
  - Only have quizzes but also have a large problem-based learning assignment, no other homeworks graded
- Alexis Ortiz-Rosario – how do you avoid/organize all the content if there are all videos/quizzes/etc?
  - Make one webpage that is roadmap for the week and keep content (quiz due dates/in class activities etc) always consistent and all videos in same page on one section of it
- Chris Bouwmeester – colleagues get pushback especially in online teaching is how to do smaller lower stakes assessments, but went overboard and now there are too many small assessments and students are overwhelmed by too much, did you get the same feedback?
  - Did not get feedback that there is too many, but main concern is being able to drop one for block quizzes which was implemented, also not many colleagues are doing low stake assignments so it's not too much
  - Some weeks there are only one quiz and coming to class, other weeks are 3 – flashcard quiz, block quiz, and class activity
  - Group activities – is this always related to doing questions as exercises or are there other types of activities being performed in class? What ones need to be improved?
    - Mostly multi-part questions on the topic for the week with some more conceptual and main place to have them solve math problems (e.g. solve differential equation related to neuron model)
    - Not as much discussion as preferred especially when solving equations, but some weeks generate lots of discussion when more conceptual such as number of actions can be controlled by BCI given EEG physiology
- Linsey Moyer – uses half class time to work on math problems and would like to do physio side via videos. Does other class (other quantitative physiology class) have same flipped structure?
  - No, not same, and it would be interesting to track and see what learning outcomes are being retained when comparing both
  - If watching 90 minute videos and cancel 50 minute lecture, students will complain that it is not a 1:1 ratio, need to set expectations to class and have them understand videos are homework
  - Lab component? No, Linsey has 4 labs and final project and classroom approach

- Salman Khetani (UI Chicago) – does traditional lecture, with online quiz weekly, 4-5 problem sets during semester, midterm, final, and R21 proposal (grad students also take it). Advantages of traditional model – in lecture they see them and can watch the students to modulate pace and engage them with Q&A, but in flipped model a student has to be motivated to view lecture videos, interact with notes, and come to class prepared and if not, exercise is difficult and professor has to fill 3 hours per week with activities students find useful. Feels like more work for both professor and student. Thoughts?
  - Lecturing is a strength and misses part of lecturing, and feels different. However, students don't have to do more work, it's just rearranged where homework is during class and lecture is out of class. Ability of students to rewatch videos is a great thing and allows them to go back and fill in gaps.
  - Salman – not more work, but perceived more work to students as they have to be motivated to be prepared to come in class to do the activities
  - Student motivation is difficult, and she doesn't get 100% attendance during group exercises and don't understand why since it will be assessed later on final exam. Students have to be internally motivated to do it. Students who started college at the start of the pandemic were hardest to be able to come in person as coming in person was a big ask to them.
- Karissa Tilbury (University of Maine) – changed it to do system definition and has prerequisites of linear algebra and calculus but they don't seem to have retained it from the prior class. How much background review on math (e.g. diff eq's) do you have to give? Has made videos but they aren't watched or they complain or like the video based on the year taught, it isn't consistent.
  - Not sure, but can share a few videos to see if there is anything different. For diff eq's, for all models used in class, only two forms of diff eq's that they will see, and goes into detail on how to solve it (e.g. neuron model has same form as one for muscle) and limit the level of diff eq math needed to know
  - Karissa – juniors have a lab section and students only stay for 1.5 hours out of 4 hours, it's a common problem across all courses to get students to stay and juniors are particularly bad, can be attributed to freshman year on campus but more online.
  - They don't have same starting point of what's normal and what's expected.
- Tomas Gonzalez Fernandez – any good books for modeling/math part of course?
  - Feher Quantitative Physiology Book, but mostly algebraic thought
  - Other resources for neuroscience and motor control
  - Not one wonderful textbook for everything
  - Megan – uses Khoo textbook with simulink examples
  - Karissa – has excellent notes from University of Pittsburg
  - Karissa – A Comprehensive Physiologically-Based Approach to Modeling in Bioengineering and Life Sciences
  - Sabia – Linda Costanzo – good medical book that medical students use but doesn't have math in it
- Chris Bouwmeester – with flashcard quiz, is there a bank of questions?
  - Yes, aims for 100 questions based on important terms so every time take get a different subset and keep highest score. Half students take multiple times.
- Sabia Abidi (Rice University) – are there a portion of students who fly vs. never see?
  - Yes, there's a bimodal distribution of who attends and asks questions/does well, but doesn't see the distribution in the final grades, is more of a normal distribution
  - Sabia - exams are hard and may be contributing to it
  - Beth – should check just for final exam