From the Editor

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Summer is here, and hopefully it brings a break from pandemic teaching for some of you! There are some staffing updates to report which are relevant to the Forum on Education. First I would like to welcome Michael Wittmann as Head of Education at APS. As part of this new position he will be a liaison to FEd. You can read more about him in the June issue of APS News. Secondly, Carl Mungan has decided to retire from his newsletter columns on Browsing the Journals and Web Watch. He has been writing these articles since Summer 2009 and we are very grateful for his long-time service to the FEd newsletter. Please join me in thanking Carl! (mungan@usna.edu)

If you have ideas for future newsletter themes, recurring columns, or an article you would like to contribute, please e-mail me at jdocktor@uwlax.edu. The deadline for the fall newsletter is October 1.

Implementing Active Learning in Physics Departments

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The APS Physics Department Chairs Conference was held virtually on June 3-4, 2021 (https://www.aps.org/programs/education/conferences/chairs/2021.cfm). One of the parallel sessions focused on Implementing Active Learning in Physics Departments with the session facilitators listed above. This article summarizes the questions raised by participants who attended the session along with notes summarizing responses from the facilitators.

What are the "nuts and bolts" of active learning?

The session began with a brief overview of active learning from David Meltzer with the following key points [1]:

- Active learning instruction is based on research about student thinking and difficulties learning physics.
- Students should engage with each other during class, such as working on some kind of problem solving activity.
- Students have opportunities to express their thinking.
- Students receive rapid feedback.
- See Physport https://www.physport.org/ for research-based resources. Additional key articles and texts are listed in references [1-5].

What are some of your experiences with implementing active learning at your institution?

Roughly two-thirds of participants attending the session indicated they currently use active learning in their physics department. Participants and facilitators shared some of their experiences, including the following:

- Whiteboards can be a useful tool for students to make their thinking visible. It is sometimes viewed as a "temporary" work space and students are more willing to make mistakes. The size of the whiteboard can be varied depending on the type of student interactions you are interested in.
- Students can solve problems at the board in front of the class. Everybody takes a turn and then nobody can hide.
- When using whiteboards for group work, allowing only one marker per group can encourage collaboration. If they each have a marker, they sometimes work individually in their corner of the board. If students are assigned specific roles in their group, it's good to rotate the roles.
- Smaller whiteboards can be used for students to provide individual responses to a question or task. The instructor can collect the whiteboards from students and select some to display anonymously and discuss as a class. See examples in the Paradigms in Physics curricular materials in ref. [6]
- Some students might express concerns about balancing time to participate in activities during class and write notes in their notebook. You can give them additional time to record notes or have them take pictures of group work with a device.
- Performance-based assessments such as a final project can be used in place of traditional exams. If the project is made publicly available online then students will become invested in their work.
- Randy noted that at Cal Poly a supportive dean provided funding and got the studio classrooms off the ground – and helped persuade chemistry to do the same – in spite of a physics chair who was not at all supportive.

How can you get students to "buy in" to using active learning in upper division courses?

Sometimes active learning techniques are seen as "elementary," so even if students have used active learning in their introductory courses they may hold different expectations for upper division physics courses. These are some strategies to enhance student buy-in:

- At the start of their junior year, teach students about how active learning works and the rationale. Highlight that real physics gets done as part of a team.
- Use hard problems, something students can't solve on their own so they see the value of collaboration.
- Emphasize that physics is something you do, an action. Incorporate kinesthetic activities early in the course.
- Provide opportunities for scientific communication.
- Survey students part-way through a course about what aspects most help their learning, and then discuss how you are responding to their feedback.

How can you get faculty to "buy in" to using active learning in upper division courses?

Physics faculty members may express concerns about active learning, such as that they won't be able to cover as much content or that if they don't explicitly show something to students they won't learn it. These are some strategies used in the Paradigms in Physics curricular materials [6].

- Reassure faculty that lectures are still needed in upper division courses but they can be shorter.
- Oftentimes students already have some knowledge they can leverage, so faculty can build on things students learned in introductory courses.
- Even if you start slower at the beginning of the course, active learning makes it possible to accelerate the course over time and still address the same topics as traditional instruction.
- Make active learning part of the culture of the physics department, so faculty see that this is how we teach physics at this institution. Chairs can help set that culture.
- Administer pre- and post-instruction learning diagnostics to provide ongoing assessments of student learning in various courses using various instructional methods. In some departments, this kind of evidence of improved student learning has proven to be a powerful persuasive tool and has significantly increased faculty buy-in.
- When there are multiple instructors of a course it's important to ensure faculty are not working at cross purposes. Watch for the possibility of covert resistance from senior faculty. Some institutions have faculty "shadow" other faculty members teaching active learning courses before they cycle into teaching that course, to become familiar with the lab activities and pedagogical approaches.
- Teaching Assistant (TA) training can be important if graduate and /or undergraduate students are teaching portions of a course, such as labs, recitations, or discussion sessions. See sample orientation resources from the University of Minnesota [7]

How will implementing active learning impact student evaluations of instruction?

Students might perceive that they learn more from lectures when they actually learn less [8], or they might have a preference for traditional (passive) instructional techniques which can influence their ratings of an instructor. These are some things to keep in mind about active learning and student evaluations:

- When applying for promotion, retention, and tenure it's important to have multiple sources of evidence for teaching effectiveness. Include direct measures (such as pre-post assessments of student learning) as well as indirect measures such as course surveys. A student assessment of learning gains (SALG) is one example, see http://salgsite.org/
- It can take a couple of years for active learning to become accepted at an institution. MIT is one example.
- Having active learning in all sections of a course is preferable. If students hear that they have to learn and think in the studio format of the class, it can get a bad reputation and students "prefer" to be in the lecture section where they can be passive.
- Be mindful that there are equity issues with student evaluations of instruction. Students may be less receptive to active learning when it is implemented by women and underrepresented minorities.
- Determine what is most valued by the administrators at your institution. Does the dean want to read students' comments about neat activities they did in a course or do they just want to see high evaluation scores (keep the students happy)?
- Be aware that research indicates student evaluations of instruction are not correlated with student learning.
- Learning outcomes assessments are big in higher ed if your institution is going up for accreditation. See examples of content-based assessments and non-content assessments on Physport. Some institutions use senior exit interviews to assess the impact of active learning instruction.

[1] *D.E. Meltzer and R.K. Thornton, Resource Letter ALIP-1: Active Learning Instruction in Physics, Am. J. Phys. 80, 478 (2012).* https://aapt.scitation.org/doi/10.1119/1.3678299

[2] *R.D. Knight, Five Easy Lessons: Strategies for Successful Physics Teaching (Pearson, 2002).*

[3] *E.F. Redish, Teaching Physics with the Physics Suite (Wiley, 2003).*

[4] *E. Mazur, Peer Instruction: A User's Manual (Prentice Hall, 1997).*

[5] *J.P. Mestre and J.L. Docktor, The Science of Learning Physics: Cognitive Strategies for Improving Instruction (World Scientific Publishing Co. Pte. Ltd., 2020).*

[6] https://paradigms.oregonstate.edu/

[7] https://groups.spa.umn.edu/physed/Research/TAOrientation/TAO_2007.html

[8] *L. Deslauriers, L. McCarty, K. Miller, K. Callaghan, and G. Kestin, Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom, Proceedings of the National Academy of Sciences 116, 19251 (2019).* https://doi.org/10.1073/pnas.1821936116