Purdue University

NOMINATION FORM FOR

HELPING STUDENTS LEARN AWARD

David B. Blasing

Name of Nominee

Graduate Student

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Title of Innovation

Conceptual iClicker series for PHYS 272 Recitations

Name of Nominator

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(if other than self)

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Nominations must be received electronically to cie@purdue.edu, no later than 5 pm, Friday, February 3, 2017.

Conceptual iClicker Series for PHYS 272 Recitations

Instructors are the mold in which their students are cast; the academic ability and character of students reflect those who taught them. Since teachers exert such powerful influence, they therefore must exhibit immense care to instill students with proper habits. Great teachers must exhibit great traits with uncommon consistency. From 2011 in the course PHYS 272, David Blasing voluntarily initiated and sustained a six-year process of pedagogical innovation based upon his teaching philosophy, which is closely intertwined with cognitive apprenticeship (CA). In CA, first a "master" models a skill, then an "apprentice" practices the skill with feedback. This continues iteratively with reducing feedback (i.e. "faded") in appropriate measure as the apprentice increasingly acquires the skill. However, CA works naturally and more easily with very low student to teacher ratios (to facilitate personalized feedback). David implemented a unique innovative version of this "model-coach-fade" teaching philosophy appropriate for courses with hundreds of students per teacher and in many various disciplines. On his demonstrated teaching excellence and innovative pedagogy, I recommend him for the 2017 Outstanding Innovation in Helping Students Learn Award.

A key innovation that allowed David to implement CA even in classrooms with unfavorably high student to teacher ratios was carefully designed and rigorously vetted series of iClicker questions. He wrote series of conceptual iClicker questions that concern primarily one skill (i.e. one concept) and became more faded by progressing in difficulty. The iClicker series themselves, and the directed conversation led by the teaching assistants have also included the final stages of CA, such as: an "articulation" and "reflection" period where students discuss the learning objective of a series, and a final "reflection" problem where the same fundamental principle is applied in another context. The applications of such structured iClicker series is not

limited to physics and can be readily adapted to any number of courses across many disciplines. In PHYS 272, the teaching assistants now use these iClicker series to rapidly adapt their feedback to the common difficulties of any number of students. Then, in a Socratic discussion, they model scientifically valid arguments based on proper physical principles. Each series is an innovative solution to addresses specific, sometimes deeply held misconceptions. After the implementation of the method specifically in PHYS 272, David conducted (with IRB approval) a research-caliber evaluation of their effect on student learning.

Part of his evaluation of the iClicker series was to gauge the attitudes of PHYS 272 students during recitation. To address this, an anonymous survey was administered for four semesters. The students voiced an incredible amount of appreciation for the iClicker series. Of 123 students, 105 recommended that PHYS 272 recitations begin with iClicker series, 8 did not, and 10 had no opinion. Approximately 80% of students either agreed or strongly agreed that the iClicker series was worthwhile. Further, a majority of students even stated that the iClicker series were the most beneficial part of recitation. The recitation iClicker series were even the second most valued component course-wide (after the homework). We know of no other systematic effort in physics education to target specific misconceptions with faded series of iClicker questions. We asked students what should be changed, the most common answer was nothing. "It makes perfect sense. I wouldn't change anything." "Best iClicker questions ever. Keep exactly the same." "They are…unlike those on WebAssign or on the exams." "DO THEM MORE!! So much more valuable than the book problems." "The recitation iClicker questions are perfect. They are difficult at times, but they do help learn the content." "The questions were really well thought out and I could tell that my TA spent a lot of time finding the right questions." "They generally helped with qualitative understanding of the concepts," and "were

very challenging, which is good for helping us understand the material." "The questions were pleasantly difficult." The "Clicker questions are seriously awesome." With the iClicker series, David struck an often-missed balance: that of being academically rigorous yet engagingly fun.

The second metric David used to evaluate the efficacy of his recitation reforms was the normalized gain of students on the Brief Electricity and Magnetism Assessment (a standard community-vetted conceptual survey in physics education research). The iClicker series occupied less than 5% of the total time students spend in PHYS 272, yet 469 students who had recitations introduced by iClicker series learned 12 ± 7% (statistically significant at $p=0.05$) more material than 355 students who did not. If one assumes that students learn proportionally to the time on task, then during the iClicker series, students were learning 5 ± 3 times faster than during the rest of the course - a remarkable achievement. David has presented this new pedagogy professionally three times at Purdue, and four times at national conferences (twice at American Association of Physics Teachers conferences, and twice at the Physics Education Research Conference). The impact of the faded iClicker series David developed is broad. Over 1200 PHYS 272 students have already directly benefited from recitations introduced by the iClicker series, with approximately 650 additional students projected every year. David will thus have measurably enhanced the learning of thousands of Purdue students before he graduates. The iClicker series have been distributed to other colleges, universities, and local high schools and David has mentored over ten other graduate TAs who now employ such pedagogy.

On a five-point scale, the average student evaluation of David is 4.65±0.05 while the average physics graduate student obtains 4.24±0.02. This approximately 10±1% difference (over 7σ) shows how exceedingly rare it is for a physics teaching assistant to sustain such high average evaluations. Twice, David had the highest student evaluation department-wide. From his course

evaluations, “David is extremely well-equipped to teach” and “is a great instructor who inspires students to devote time and effort to Physics.” He is “very invested in helping his students understand the material” and “unlike many experts in his field” “does a good job encouraging and explaining things to students who do not understand the material” and yet “his explanations are clear for everybody.” “I would have no idea what was going in this class without [his] recitations.” David “is very, very good at making people think and is very, very good at getting people to understand concepts well.” He “is one of the best teachers that I have ever had.”

In addition to his responsibilities in recitation, David has applied CA in every aspect of PHYS 272. He has taught 41 sections of laboratory and recitation (1165 students total), led the course 4 times as the sole lecturer (87 students total), and has four times coordinated the entire course (1282 students total and 84 staff coordinated). During his involvement, PHYS 272 enrollment has increased by about thirty students each year. With his expertise, he also created 29 new lectures, and significantly enhanced the laboratories as well. In laboratory, he successfully wrote 2 College of Science equipment grants that brought over $30,000 of funding into the physics department. Then, he arranged the laboratories to follow the steps of CA and created new laboratories when needed. The first six laboratories use computational analysis to describe physical phenomenon and have a high amount of structure and feedback. The teaching assistants (the “masters”) and the provided code model various physics phenomenon (the “skills”). The next five laboratories are more faded and allow the students to make measurements. Teaching assistants offer feedback in appropriate amounts, perhaps by demonstrating measurement techniques or by describing the physical phenomena. The final laboratory, by David’s design, is the most “faded.” Students are challenged to discover the contents of thirteen black boxes that are completely sealed save for two electrical connections.

They are free to design any experiment with any equipment in the laboratory. The students find such freedom both enjoyable and pedagogically valuable. So now CA informs both the structure of individual laboratories and the overall progression of the laboratories throughout the semester; we are unaware of another university using CA so comprehensively in physics laboratory.

David has presented his innovative applications of CA in such large classrooms professionally seven times in poster sessions, three times at Purdue and four times nationally at two American Association of Physics Teachers summer conferences, and two Physics Education Research Conferences. His work has resulted in 4 publications in preparation for submission to peer reviewed teaching journals, two from his work in recitation and two from his work in laboratory. Twice, David was selected to lead a required, graduate level pedagogy course for incoming graduate teaching assistants (51 graduate students total taught). David has undoubtedly left a lasting impact on the physics department by shaping the younger generation of graduate teaching assistants. David is a previous recipient of the 2013 Gabriele F. Giuliani Outstanding First or Second Year Teaching Assistant Award, the 2014 Teaching Academy Graduate Teaching Award, the 2015 Akeley-Mandler Award for Teaching Excellence, and an Advanced Graduate Teaching Certificate from the Center of Instructional Excellence. David's excellence in teaching has been measured in PHYS 272, has impacted the teaching philosophies of the next generation of physics graduate teaching assistants, and his innovative instructional materials have spilled out from Purdue University. For all his contributions, those measured and those unmeasured, I enthusiastically recommend him for the 2017 Outstanding Innovation in Helping Students Learn Award.

Physics and Astronomy Memorandum

To: Helping Students Learn Selection Committee

From: Andrew Hirsch

Date: January 31, 2017

Re: Nomination of David Blasing

In PHYS 272 over the last six years, David Blasing has sustained an uncommon excellence in teaching by voluntarily creating and implementing a unique, innovative pedagogy that adapts and applies the core principles of cognitive apprenticeship. Cognitive apprenticeship is exceedingly difficult to apply in courses like PHYS 272 with high student to teacher ratios. The low individual contact time per student creates difficulty for offering specific real-time feedback to students as they learn. He solved this problem by creating carefully designed and rigorously vetted series of iClicker questions that allow teaching assistants to progress through the stages of cognitive apprenticeship with an entire classroom. Although his specific application was in PHYS 272, the pedagogical methods he developed are not specific to physics and have application in any classroom capable of polling students in real-time.

Over 1200 students at Purdue in PHYS 272 have already had their learning measurably enhanced by his pedagogy, and the instructional materials he developed have spilled out into high schools and colleges beyond Purdue. These structured series target specific misconceptions that recur semester after semester. In PHYS 272, these series took only 15 minutes per week, but resulted with students learning 12 ± 7% more material on the Brief Electricity and Magnetism Assessment after the entire semester. If one assumes that students learn proportionally to the time on task, then during the iClicker series, students were learning 5 ± 3 times faster than during the rest of the course - a remarkable achievement. Further on surveys, students indicate that the iClicker series strike the balance between being academically rigorous yet engagingly fun and accessible. These iClicker series help make learning physics more enjoyable. For his applications of cognitive apprenticeship in PHYS 272, I nominate David Blasing for the 2017 Helping Students Learn Award.