Investigation of PeerWise Pedagogy to Promote Future Physics Teachers' Pedagogical Content Knowledge From Theory to Practice

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SPACE ÉDUCATIF

USING PEERWISE TO PROMOTE STUDENT COLLABORATION ON DESIGN OF CONCEPTUAL MULTIPLE-CHOICE PHYSICS QUESTIONS

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Every physics instructor who ever used clicker-enhanced pedagogy knows that coming up with pedagogically effective conceptual questions is challenging. These questions are often provided by the undergraduate textbook authors [1], but are not yet as common in K-12 physics textbooks. For the past three years our research team has been working on designing conceptual physics questions relevant to British Columbia Secondary Physics Curriculum and implementing them in the Secondary Physics Methods courses at UBC Teacher Education Program [2].

The process of creating meaningful multiple-choice conceptual questions has significant pedagogical implications [3]. It requires the author to think not only of the correct solution, but also of possible misconceptions (distractors) and potential student difficulties. This unfortunately is rarely done by the physics students. What if the students were asked to design conceptual multiple-choice physics questions? What if th... ...llaboratively? What if they could ...

contributed to PeerWise database has the fields displayed in Table 1.

In addition, PeerWise collects statistics on participants' reputation which is impacted by the number of questions they designed, by the peer rating of these questions, and by the number of their correct answers to the questions contributed by peers. Lastly, based on their reputation and answering scores, the students can earn badges, which fosters a competitive game

TABLE 1
QUESTION FEATURES AND AVAILABLE FIELDS OF THE PEERWISE SYSTEM

Database field	Descripti...
Question's stat...	

Milner-Bolotin, M. (2014). Using PeerWise to promote student collaboration on design of conceptual multiple-choice questions. *Physics in Canada, 70*(3), 149-150.

Study Context

- Secondary Physics Method Course at the UBC Teacher Education Program
- 8 future teachers
- Course Instructor – Dr. Marina Milner-Bolotin
- Teaching Assistant – Davor Egersdorfer
- Research Assistant – Murugan Vinayagam

Peer Instruction (PI)

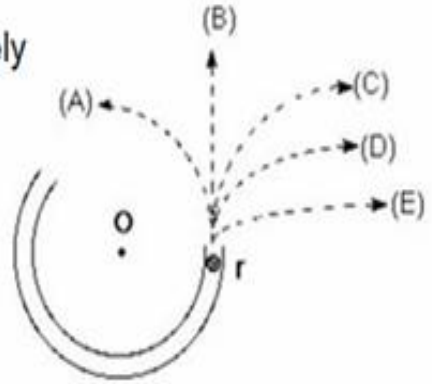
- Engages students in answering conceptual multiple-choice questions that:
  - target student difficulties
  - use common misconceptions as distractors

- Makes use of Classroom Response Systems (clickers) or flashcards

Question

A ball travels through the circular track until point r, at which point it leaves the channel to travel across a frictionless floor. Assume a bird's eye view, and that all motion is in the horizontal plane.

Which path will the ball most closely follow after it exits the channel?



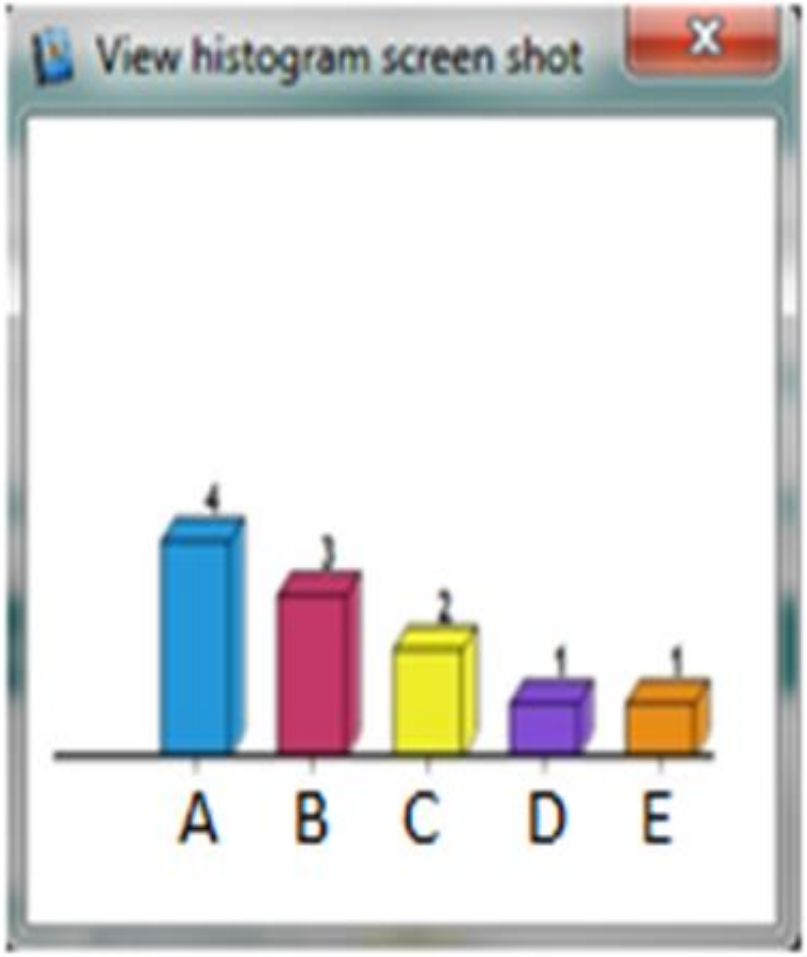
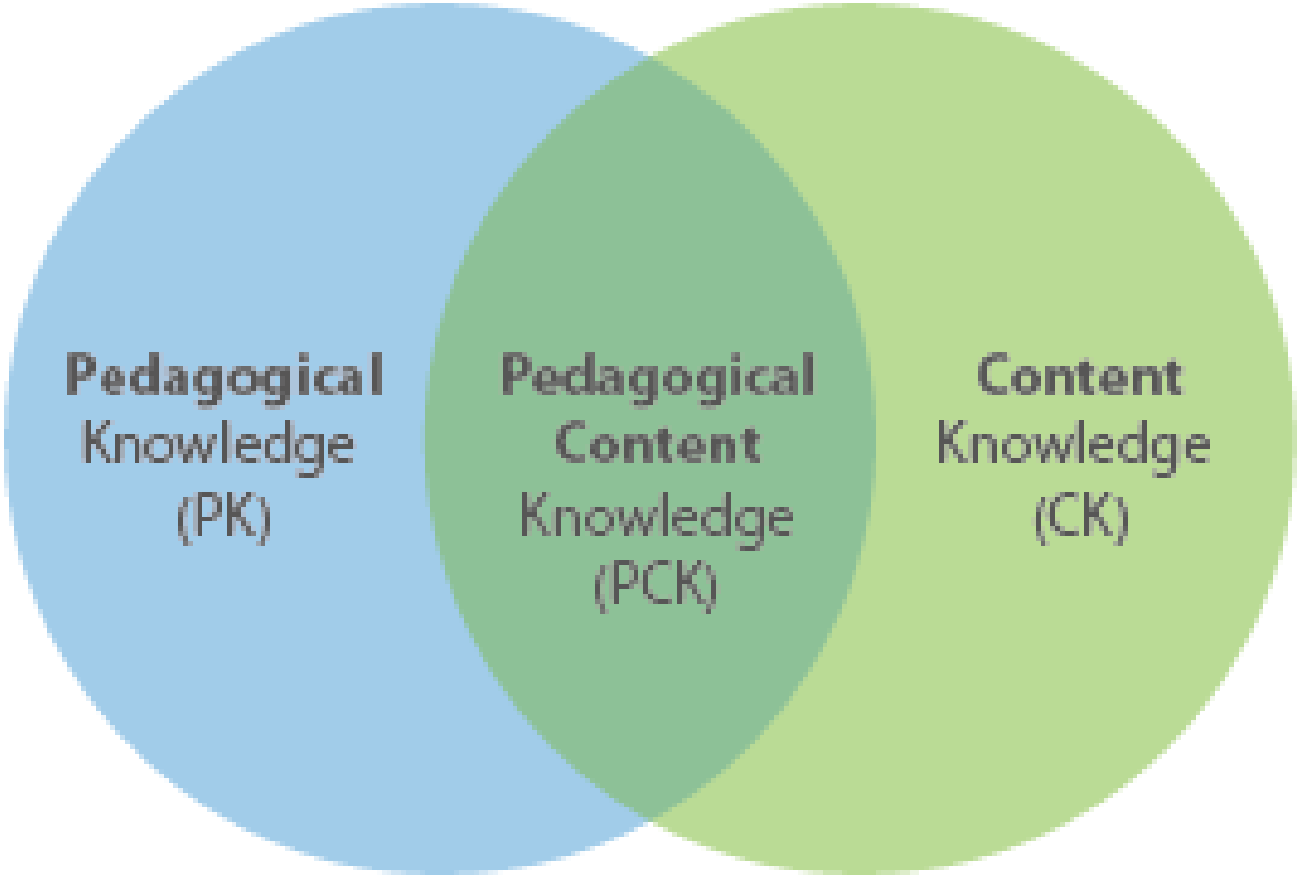


Figure 1: An example of a conceptual multiple-choice question and the distribution of students' responses. The correct answer B was chosen by 3 out of 11 students.

Pedagogical Content Knowledge (PCK)

PCK is knowledge *for teaching specific content* (Schulman, 1986)



http://iteacher.pxl.be/tpack

PeerWise

https://peerwise.cs.auckland.ac.nz/

- An online collaborative platform for hosting student-authored multiple-choice questions (Denny, 2015)

- Allows students to answer, rate, and comment on multiple-choice questions created by their peers.

PeerWise Implementation

Cycle	Week	Expected Tasks
1	1	Author at least six questions and upload them to PeerWise
	2	Answer at least 10 questions designed by your peers Provide comments on at least five of the questions you answered
2	3	Review all relevant comments on your questions and respond when applicable Modify at least three of your questions to address the comments Author at least three additional questions
	4	Answer at least 10 questions designed by your peers Provide comments on at least five questions you answered
Cycle 2 repeats every two weeks for the duration of the course		

Analysis of PeerWise Questions

- Analyzed PCK quality of PeerWise questions (Bloom, 1956)
- Weeks 2-3 vs. Weeks 11-13
- Preliminary results show a significant increase in the quality of future physics teachers' PCK

Why should I use PeerWise in my classroom?

- Students learn content by asking/answering questions
- Can be used with regular students
- Gaming element (student engagement)
- Can be used for any subject
- Lots of support

Why should I use PeerWise in my classroom?

- Does not require computers in the classroom
- Once implemented, requires minimal input from the teacher
- Promotes collaboration and peer learning
- Students learn how to provide positive, constructive feedback
- Free
- Easy to use

Resources

- Bloom, B. S. (1956). *Taxonomy of Educational Objectives: Cognitive Domain* (1st ed.). New York: Longmans, Green.
- Denny, P. (2013). The effect of virtual achievements on student engagement. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '13* (pp. 763–772). doi:10.1145/2470654.2470763
- Denny, P. (2015). *PeerWise*. Retrieved April 1, 2015, from https://peerwise.cs.auckland.ac.nz/
- Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, *66*(1), 64–74. doi:10.1119/1.18809
- Milner-bolotin, M., Fisher, H., & Macdonald, A. (2013). Modeling Active Engagement Pedagogy through Classroom Response Systems in a Physics Teacher Education Course. *LUMAT: Research and Practice in Math, Science, and Technology Education*, *1*(5), 523–542.
- Mishra, P., & Koehler, M. J. (2007). Technological pedagogical content knowledge (TPCK): Confronting the wicked problems of teaching with technology. In *Society for Information Technology & Teacher Education International Conference* (Vol. 2007, pp. 2214–2226). Retrieved from http://www.editlib.org/p/24919/

Why use questions to teach?

- Challenge misconceptions
- Engage students and encourage participation
- Stimulate discussion
- Determine how students are thinking
- In order to ask/answer good conceptual questions you need to know the content

Future Directions

- Analyze the comments that TCs provided, to see how they changed over the time during the course

- A follow up study could be implemented to see if the TCs maintain their increased PCK and if they use PI techniques within their classrooms