DEPARTMENT OF CURRICULUM & PEDAGOGY
THE UNIVERSITY OF BRITISH COLUMBIA

EDCP 585A: Science and Mathematics Teaching and Learning through Technologies

Course Details

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UBC, 2125 Main Mall, Vancouver, B.C., V6T 1Z4
Course: EDCP 585A Section 971
Time: July 3 – 20, 2012, Monday – Friday 8:00 am – 10:30 am.
Room: Scarfe 1210

Course Description and Goals:

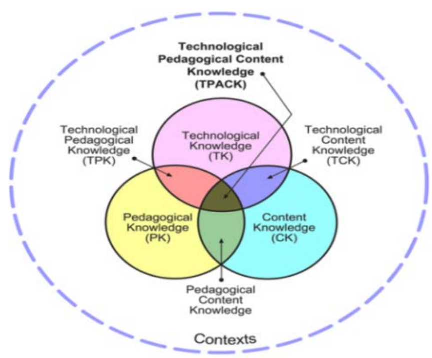

Figure 1: Technological-Pedagogical Content Knowledge Framework: http://www.innovativelearning.com/instructional_technology/tpck.html

In the 21st century, students' abilities to grasp complex mathematics and science concepts, collect and analyze real time data, make sense of the science- and mathematics- rich information and conduct independent investigations have become increasingly important. At the same time, rapid advances of modern educational technologies allowed contemporary mathematics and science educators to have an unprecedented range of opportunities to engage their students in meaningful science and mathematics learning. These two trends have significantly affected the teaching of these disciplines and the pedagogical skills required of contemporary mathematics and science teachers in order to succeed. Teachers have to acquire not only the pedagogical and disciplinary content knowledge, but also the knowledge of content-specific educational technologies and relevant pedagogies. **The in-depth exploration of this knowledge (often referred to as Pedagogical-Technological Content Knowledge or TPCK [1, 2]), the ways mathematics and science teachers acquire it and learn to implement technology into their practice is the goal of the current course** (Figure 1).

Course Scope: Explore theoretical background and applications for technology-enhanced learning and teaching of science and mathematics

In the current course, we explore the theoretical background for design, implementation and the educational impact of different science and mathematics technology-enhanced learning environments, such as:

1) **Peer Instruction** [3]: design of electronic response systems (clickers) enhanced learning environments [4-7] in mathematics and science [8-10].
2) **Mathematics and science modeling:** the use of modeling software to promote meaningful science and mathematics learning (i.e., Geogebra; Geometer's Sketchpad, graphing calculators and video-analysis) [11-14].
3) **Real-time data collection and analysis:** the use of sensors or probeware that allow students to acquire data in order to test their ideas and construct meaningful mathematics and science knowledge (i.e., Logger *Pro*) [15-21].
4) **Computer simulations and data visualization**: the use of computer simulations to conduct virtual investigations, simulate science and mathematics problems and test ideas (i.e., PhET) [22-25].
5) **Mathematics and science games and video games** as a tool to develop critical thinking in the context of mathematics and science learning [26].

Course participants will conduct a relevant literature review and develop criteria for evaluating educational technology design and implementation from the perspective of mathematics and science learning, pedagogical sustainability and impact on student understanding and engagement in mathematics and science. In order to link the theory to practice, the students will apply these criteria for designing and evaluating their own technology-enhanced science or mathematics educational experiences that foster active inquiry and meaningful understanding: an Educational Technology Exploration paper (theoretical analysis) and an Educational Technology Project Grant Proposal (practical application) in the context of mathematics and science teaching and learning. The Project will be an example of an educational-technology grant that will (a) allow the students to apply their theoretical knowledge to practice in their area of interest; (b) include an analytic rationale component, a practical design and an evaluation for sustainability and pedagogical effectiveness; (c) be presented and peer evaluated by the course participants.

The course focuses on the principles of effective technology-enhanced pedagogical designs for successful science and mathematics learning in K-12 schools. It aims at engaging the students with the issues of research-based design, implementation and evaluation of technology-enhanced science and mathematics teaching and writing grant proposals for educational technology-driven projects in the context of science and mathematics. The course is intended as a graduate seminar and will require a rigorous level of intellectual engagement on behalf of the participants and ability to apply theoretical knowledge to classroom practice.

Course Delivery (content areas and tentative schedule)

Content Area 1: How People Learn Science and Mathematics – A case for technology

Meetings 1-5: We begin the course with exploring the implications of learning theories (i.e., constructivism and social constructivism) on science and mathematics teaching and learning.

Meetings 1-2: Learning theories and their applications on design and implementation of effective science and math technology-enhanced learning environments

Critical question: How should our knowledge of science and mathematics learning affect the design and implementation of technology-enhanced learning environments?

Key readings and online resources: 1 and 2 are key readings for the course; 4 is a very interesting project; 5 – an inspirational video on science teaching and learning.

1. Bransford, D., Brown, A. L., & Cocking, R. R. (2002). *How people learn: Brain, Mind, Experience, and School*. Washington, DC: National Academy Press. (Free online: http://www.nap.edu/openbook.php?isbn=0309070368)
2. Donovan, M. S., & Bransford, J. D. (Eds.). (2005). *How Students Learn: History, Mathematics, and Science in the Classroom*. Washington D.C.: Division of Behavioral and Social Sciences and Education, The National Academic Press. (Free: http://www.nap.edu/openbook.php?record_id=10126&page=1)
3. Mazur, E. (1997). *Moving the Mountain: Impediments to Change*. The Physics Teacher, 35(10), 1-4.
4. A Private Universe Project: http://www.learner.org/teacherslab/pup/ (A very revealing investigation of how students learn science… and how we teach it…)
5. Mazur, E. (Producer). (2010, February 24, 2011) Confessions of a Converted Lecturer. Video archive retrieved from http://pirsa.org/10110081/

Meetings 3-4: Inquiry-based science and mathematics teaching and learning – a case for technology integration

Critical question: How can technology support inquiry-based science and mathematics teaching and learning?

Key readings: 1 and 2; Notice references 5 and 6.

1. Papert, S. (1980). *Mindstorms: Children, Computers and Powerful Ideas*. New York: Basic Books, Inc., Publishers. (Available online: http://www.arvindguptatoys.com/arvindgupta/mindstorms.pdf)

2. Lee, H.-S., Linn, M. C., Varma, K., & Liu, O. L. (2010). How Do Technology-Enhanced Inquiry Science Unit Impact Classroom Learning? *Journal of Research in Science Teaching, 47*(1), 71-90.
3. Hew, K., & Brush, T. (2007). *Integrating technology into K-12 teaching and learning: current knowledge gaps and recommendations for future research*. Educational Technology Research and Development, 55(3), 223-252.
4. Hoyles, C., & Noss, R. (2008). Next steps in implementing Kaput's research programme. *Educational Studies in Mathematics, 68*(2), 85-97.
5. Powers of Ten: http://www.powersof10.com/ an online resource for mathematics teachers (based on the film by Charles and Ray Eames).
6. Deslauriers, L., Schelew, E., & Wieman, C. (2011). Improved Learning in a Large-Enrollment Physics Class. *Science, 332*(6031), 862-864.

Class 5: Development of critical thinking in the context of technology-enhanced science and mathematics classroom

Critical question: How should science and mathematics educators use technology to support the development of critical thinking in the mathematics and science education contexts?

Key readings:1, 3 & 4.

1. Healy, L., & Hoyles, C. (1999). Visual and Symbolic Reasoning in Mathematics: Making Connections With Computers? *Mathematical Thinking and Learning, 1*(1), 59-84.
2. Noss, R., Healy, L., & Hoyles, C. (1997). The Construction of Mathematical Meanings: Connecting the Visual with the Symbolic. *Educational Studies in Mathematics, 33*(2), 203-233.
3. Noss, R., Hoyles, C., Lesh, R., Haines, C. R., Galbraith, P. L., & Hurford, A. (2010). Modeling to Address Techno-Mathematical Literacies in Work. In *Modeling Students' Mathematical Modeling Competencies* (pp. 75-86): Springer US.
4. Finkelstein, N. D., Adams, W. K., Keller, C. J., Kohl, P. B., Perkins, K. K., Podolefsky, N. S., et al. (2005). When learning about the real world is better done virtually: A study of substituting computer simulations for laboratory equipment. *Physical Review Special Topics - Physics Education Research, 1*(1), 010103.

Content Area 2: Educational Technology Implementation in Mathematics and Science Classroom

Meetings 6-9: We will narrow down our exploration to specific educational technologies and discuss the key elements of technology-enhanced pedagogies in mathematics and science classroom. One of the main foci of our investigation will be the development of teachers' Technological-Pedagogical Content Knowledge.

Meetings 6-7: Contemporary educational technologies in science and mathematics

Critical questions: What are the strength and weaknesses of modern educational technologies in mathematics and science classroom? Why would you choose or not choose to use them in a science or mathematics classroom and how would you convince your colleague to do the same?

Key readings: 2, 3, 5; you can replace any two of these readings by the relevant reading of your choice.

1. Antimirova, T., & Milner-Bolotin, M. (2009). A Brief Introduction to Video Analysis. *Physics in Canada*, **65** (April-May): p. 74.
2. Beatty, I.D., et al., Designing effective questions for classroom response systems teaching. *American Journal of Physics*, 2006. **74**(1): p. 31-39.
3. Campbell, T., Wang, S. K., Hsu, H.-Y., Duffy, A. M., & Wolf, P. G. (2010). Learning with Web Tools, Simulations, and Other Technologies in Science Classrooms. *Journal of Science Education Technology*, **19**: p. 505-511.
4. Dugdale, S., *The design of computer-based mathematics instruction*, in Computer assisted instruction and intelligent tutoring systems: Shared issues and complementary approaches, J.H. Larkin and R.W. Chabay, Editors. 1992, Erlbaum: Hillsdale, NJ. p. 11-45.
5. Gee, J.P., Learning by Design: good video games as learning machines. *E–Learning*, 2005. **2**(1): p. 5-16.
6. Milner-Bolotin, M. (2004). Tips for Using a Peer Response System in Large Introductory Physics Classroom. *The Physics Teacher*, **42**(8): p. 47-48.

Meetings 8-9:

Critical questions: What are the strength and weaknesses of 3 modern educational technologies of your choice? Why would you choose or not choose to use them in a science or mathematics classroom and how would you convince your colleague to do the same?

Key readings: 1, 2, 5 you can replace any two of these readings by the relevant reading of your choice

1. Milner-Bolotin, M., A. Kotlicki, and G. Rieger. (2007) Can Students Learn from Lecture Demonstrations: The Role and Place of Interactive Lecture Experiments in Large Introductory Science Courses. *Journal of College Science Teaching*, **36**(4): p. 45-49.

2. Hohenwarter, J., Hohenwarter, M., & Lavicza, Z. (2008). Introducing Dynamic Mathematics Software to Secondary School Teachers: The Case of GeoGebra. *Journal of Computers in Mathematics and Science Teaching*, **28**(2), 135-146.
3. Sinclair, N., & Yurita, V. (2008). To be or to become: How dynamic geometry changes discourse. *Research in Mathematics Education*, **10**(2): p. 135-150.
4. Sokoloff, D. R., & Thornton, R. K. (1997). Using Interactive Lecture Demonstrations to Create an Active Learning Environment. *The Physics Teacher*, 35(September): p. 340-347.
5. Wieman, C. E., Adams, W. K., Loeblein, P., & Perkins, K. K. (2010). Teaching Physics Using PhET Simulations. *The Physics Teacher,* 48(April), 225-227.

Content Area 3: Development of Mathematics and Science Teachers' Technological-Pedagogical Content Knowledge

Meetings 10-11: We will focus on the development of mathematics and science teachers' Technological-Pedagogical Content Knowledge (TPCK) and explore how they can be supported in successful implementation of educational technologies in their classrooms.

Meeting 10: Development of Technological-Pedagogical Content Knowledge

Critical questions: What is Technological-Pedagogical Content Knowledge? How is it different from pedagogical or content knowledge? How can it be developed?

Key readings:1-2.

1. Ertmer, P. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research and Development*, ***53***(4): p. 25-39.
2. Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education*, **9**(1): p. 60-70.
3. Koehler, M. J., & Mishra, P. (2005). What happens when teachers design educational technology? The development of technological pedagogical content knowledge. *Journal of Educational Computing Research*, **32**(2): p. 131-152.
4. Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record*, **108**(6): p. 1017–1054.

Meeting 11: Professional development for science and mathematics teachers: supporting teachers' Technological-Pedagogical Content Knowledge

Critical question: What are the key elements for the design and implementation of effective Professional Development to support the development of teachers' Technological-Pedagogical Content Knowledge?

(Key readings –1-2**)**

1. Niess, M. L. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and Teacher Education,* **21**: p. 509-523.
2. Varma, K., Husic, F., & Linn, M. C. (2008). Targeted Support for Using Technology-Enabled Science Inquiry Modules. *Journal of Science Educ. Technology*, ***17***: p. 341-356.

Course Assessment

A. Class participation – No grade

Active participation in discussions is expected. While no grades are allotted for attendance, in order to attain a passing grade, students are expected to attend a minimim of 80% of classes.

B. Educational Technology Debaters – 15% (7.5% per debate – 2 debates)

Educational Technology Debaters focus on discussing pros and cons of different educational technologies. Every student will be asked to participate twice as a pro and con educational technology expert. You will have a maximum 3 minutes to express your ideas pro or against a specific educational technology. You will need to find a partner for each one of the debates and choose your role (pro or con). We will evaluate the debates collectively using clickers. Every participant will be able to choose the educational technologies he/she will be debating.

C. Student-led in-class discussion (one) – 25%

You will be asked to lead an in-class discussion on one of the selected readings (the reading choice has to be discussed with the instructor). Each discussion will take 25 minutes and will have two students to facilitate it. The students will need to sign up for the discussion at the beginning of the course. The discussion will consist of a 10 minute presentation (as an opportunity to engage the group in a critical discussion of various ideas, themes, issues, etc. raised by the author(s)) and a 15 minute follow up conversation. You are expected to lead a meaningful and engaging discussion that will help the group to make sense of the required readings and think of new ideas and possibilities. You should be open for questions from your colleagues. Particularly important in this discussion are the links between these readings, personal experiences and other issues previously discussed in this course or in other courses.

D. Learning and teaching mathematics and science with technology – 30%

Due: Meeting 10

You are asked to submit a short Analytic Educational Technology Exploration Paper (up to 2,500 words excluding references) that discusses and illuminates one of the class discussions shedding light on implementation of educational technologies in mathematics and science classroom. You might choose to write a paper on the topic you facilitated (however, it is not required – any course relevant topic might be chosen). The paper should involve a pertinent literature review, a clear issue formulation, which should stem from the rigorous analysis of the assigned readings and your personal experiences and it should offer possible ways of addressing the problems raised or ways of finding the solution. In addition, it is important that you provide a brief reflection on how these ideas may impact your own teaching or research. The paper should be submitted electronically via WebCT-Vista (Assignment menu) either as a pdf or a Word file. You should start thinking about this paper from the very beginning of the course. The marking rubric for the paper is posted below.

E. Grant Project Proposal & Presentation – 30% (Proposal 15%, presentation 15%)

Due: Meeting 12

As a summary, you are asked to write a draft of a grant proposal that suggests a creative way of incorporating educational technology into classroom practice. This will require you to incorporate the knowledge you gained in this course and your prior experiences to assume a leadership role in technology-enhanced mathematics and science teaching. You will be required to look for different agencies that accept such proposals and write up the summary, theoretical background and the rational for your grant. You can pick any potential agency and write the proposal having it in mind. For example, this might a Microsoft Educational Grants (http://www.microsoft.com/industry/publicsector/grants.mspx#EZB), the grants from local agencies such as Vancouver School Board, Vancouver Foundation or a professional organization (for example National Science Teachers' Association: www.nsta.org). The Proposal should clearly outline the problem you are trying to address and how it will be solved using this technology. You are required to prepare a 10-minute presentation that offers an overview of the Proposal. A few of successful educational technology grant proposals by Dr. Milner-Bolotin will be uploaded on the course web site as examples. The format of this assignment will depend on the requirement of the specific granting agency of your choice.

Format of Written Assignments

Written assignments (Assignment 'D') should not exceed the word limit (excluding references) and all text should be double-spaced, Times New Roman 12 point or equivalent. Please follow conventional academic format and style and include references (please use A.P.A. guidelines: http://www.okanagan.bc.ca/Page10234.aspx). Ensure that documents are coherent, thoroughly spell-checked and checked for grammar, punctuation and other errors. Assignment 'E' should follow the guidelines of the granting agency.

Policies for Absences & Late Assignments

Absences: Students are expected to attend and actively participate in **all classes**; however, there are times when this may not possible. If a student is going to be absent, it is their responsibility to notify the instructor via email at least 24 hours prior to the start of class. Please check the UBC Attendance policy that outlines what are considered 'unavoidable' absences.

Late Assignments: Students are expected to hand all work in on time. Papers will not be accepted late – you can submit all papers online. For the student led discussion, if a student is unable to attend on the day they are to lead the class in this activity, they must notify the instructor at least 24 hours ahead (again, check the UBC Attendance policy for 'unavoidable' absences) and then work out an alternative arrangement with the instructor once they have returned to class. In the case of a medical illness, a medical certificate may be required.

Grading Guidelines for Assignments[1]:

A level - Good to Excellent Work

A+ (90-100%): A very high level of quality throughout every aspect of the work. It shows the individual (or group) has gone well beyond what has been provided and has extended the usual ways of thinking and/or performing. Outstanding comprehension of subject matter and use of existing literature and research. Consistently integrates critical and creative perspectives in relation to the subject material. The work shows a very high degree of engagement with the topic.

A (85-89%): Generally a high quality throughout the work. No problems of any significance, and evidence of attention given to each and every detail. Very good comprehension of subject and use

[1] *EDCP Grading Guidelines for Graduate level courses* - *July 2008*

of existing literature and research. For the most part, integrates critical and creative perspectives in relation to the subject material. Shows a high degree of engagement with the topic.

A- (80-84%): Generally a good quality throughout the work. A few problems of minor significance. Good comprehension of subject matter and use of existing literature and research. Work demonstrates an ability to integrate critical and creative perspectives on most occasions. The work demonstrates a reasonable degree of engagement with the topic.

B level - Adequate Work

B+ (76-79%): Some aspects of good quality to the work. Some problems of minor significance. There are examples of integrating critical and creative perspectives in relation to the subject material. A degree of engagement with the topic.

B (72-75%): Adequate quality. A number of problems of some significance. Difficulty evident in the comprehension of the subject material and use of existing literature and research. Only a few examples of integrating critical and creative perspectives in relation to the subject material. Some engagement with the topic.

B- (68-71%): Barely adequate work at the graduate level.

C & D level - Seriously Flawed Work[2]

C *(*55-67%): Serious flaws in understanding of the subject *material.* Minimal integration of critical and creative perspectives in relation to the subject material. Inadequate engagement with the topic. Inadequate work at the graduate level.

Academic Honesty and Standards

This course is governed by UBC's Standards for Academic Honesty:

> "Academic honesty is essential to the continued functioning of the University of British Columbia as an institution of higher learning and research. All UBC students are expected to behave as honest and responsible members of an academic community."

For more information, visit: *http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,286,0,0*

[2] **NOTE:** For UBC's Faculty of Graduate Studies (FOGS), a final mark below 68% for Doctoral students and below 60% for Masters students is the equivalent of a Failing mark.

Grading Rubrics for Educational Technology Exploration Paper

Qualities & Criteria	Poor (0-80)	Good (80-90)	Excellent (90-100)
Format/Layout • Text presentation • Text structuring • Requirements of length, font and style are followed *(Weight 10%)*	Follows poorly the requirements related to format and layout.	Follows, for the most part, all the requirements related to format and layout. Some requirements are not followed.	Closely follows all the requirements related to format and layout.
Content/Information			
Framing the issue: • Clear issue presentation • Clear explanation how it is important to you • The issue is grounded in the course activities and the literature *(Weight 20%)*	The issue is not presented clearly and it is not clear how it is personally relevant and interesting to you. No clear case for the relevance of the issue to the class discussions is made. The issue is not grounded in the course activities and literature.	The issue is presented clearly but it is not clear how it is personally relevant and interesting to you or how it should be of interest to the readers. The issue is grounded in some of the course activities.	The issue is presented clearly emphasizing how and why it is personally relevant and interesting to you or how it should be of interest to the readers. It is grounded in the course activities and literature (i.e. auto-e-ography, video cases, and the interview).
Analyzing the issue: • **Position of the paper** • **Logical and coherent analysis** • **Analysis of the paper from multiple perspectives** *(Weight 20%)*	The position of the paper is not situated within the contemporary discourse. The analysis is lacking breadth and depth.	Paper position is somewhat situated within contemporary discourse. Only one perspective on the issue is identified and the literature analysis is incomplete. Not all key issues/ concepts are identified.	Paper position of is situated clearly within contemporary discourse. Multiple perspectives on the issues are identified. The patterns coming out of the literature are located and main points, arguments, and key concepts are pointed out.

Critical analysis of the paper position and suggestions of future directions. *(Weight 20%)*	The author does not offer a constructive critique of the used literature and perspectives. New contributions or new directions for research and practice are not suggested.	The author offers some constructive critique of the used literature and perspectives. Yet limited new contributions or new directions for research and practice are offered.	The author offers a constructive critique on the collection of articles and perspectives, states a position, and suggests new contributions or new directions for research and practice.
Quality of Writing • Clarity of sentences and paragraphs • No errors and spelling, grammar and use of English • Organization and coherence of ideas *(Weight 20%)*	The paper is poorly written, and contains many spelling and/or grammar errors. It is badly organized, lacks clarity and/or does not present ideas in a coherent way.	The paper is mostly well written, without spelling or grammar errors. It is organized but the arguments are not always clear and the ideas are not transparent to the reader.	The paper is well written from start to finish, without spelling or grammar errors. It is well organized, clear and presents ideas in a coherent way. The arguments are lucid and transparent to the reader.
References and use of references • Scholarly level of references • How effective the references are used in the paper • Soundness of references • APA style in reference list and for citations *(Weight 10%)*	Most of the references used are not important, and are not of scholarly quality. The resources are not used effectively. The references are not correctly cited and/or listed in the reference list according to APA style.	The paper references few references from the resource folders or course bibliography. Only few of the references are important, and not all of them are of scholarly quality. Most of the references are effectively used, correctly cited and listed in the reference list according to APA style.	The paper references articles from the resource folders, course bibliography and other sources, such as the ERIC or Academic Search Premier library databases. All the references are relevant and important, and are of scholarly quality. All the references are effectively used, correctly cited and correctly listed in the reference list according to APA style.
Overriding criterion: Originality and authenticity. If the paper is identified as not being original, and/or not done by the student, the instructor has the right to grade the paper as an F.			

References and Selected Online Resources for Mathematics and Science Teaching and Learning:

1. Critical Learning Instructional Path Supports (interactive activities in K-12 Math developed in Ontario: http://oame.on.ca/CLIPS/)
2. Gapminder: For a fact-based world view – unveiling the beauty of statistics (with Professor Hans Rosling) www.gapminder.org
3. Khan academy: http://www.khanacademy.org/
4. Inverted classroom: http://en.wordpress.com/tag/inverted-classroom-teaching/; http://www.slideshare.net/rtalbert/inverting-the-classroom-improving-student-learning?from=category_featured_email
5. SMART Exchange: http://exchange.smarttech.com/index.html#tab=0
6. MERLOT – Multimedia Educational Resource for Learning and Online Teaching: http://www.merlot.org/merlot/index.htm
7. ComPADRE: Resources for physics and astronomy education www.compadre.org
8. The biology corner: http://www.biologycorner.com/ - resource site for biology and science teachers.
9. Resources for biology teaching: http://www.ascb.org/ivl/design/education.html
10. Resources for mathematics education: National Council of Teachers of Mathematics http://www.nctm.org/
11. National Science Teachers Association: www.nsta.org

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1. Koehler, M.J. and P. Mishra, *What is technological pedagogical content knowledge?* Contemporary Issues in Technology and Teacher Education, 2009. **9**(1): p. 60-70.
2. Jimoyiannis, A., *Designing and Implementing an Integrated Technological Pedagogical Science Knowledge Framework for Science Teachers Professional Development.* Computers & Education, 2010. **55**(3): p. 1259-1269.
3. Lasry, N., E. Mazur, and J. Watkins, *Peer Instruction: From Harvard to the two-year college.* American Journal of Physics, 2008. **76**(11): p. 1066-1069.
4. Lasry, N., *Clickers or Flashcards: Is There Really a Difference?* The Physics Teacher, 2008. **46**(May): p. 242-244.
5. Yourstone, S.A., H.S. Kraye, and G. Albaum, *Classroom Questioning with Immediate Electronic Response: Do Clickers Improve Learning?* Decision Sciences Journal of Innovative Education, 2008. **6**(1): p. 75-88.
6. Hoffman, C. and S. Goodwin, *A clicker for your thoughts: technology for active learning.* New Library World, 2006. **107**(1228/1229): p. 422-433.
7. Duncan, D., *Clickers in the Classroom*. 2005, San-Francisco, Boston, NY: Pearson Education. 72.
8. Beatty, I.D., et al., *Designing effective questions for classroom response systems teaching.* American Journal of Physics, 2006. **74**(1): p. 31-39.
9. Milner-Bolotin, M., J. Cha, and K. Hunter, *Investigating Science Questioning Practices of Elementary Pre-Service Teachers: Design of Elementary Science Questions Evaluation Rubric*, in *American Educational Research Association Annual Meeting*. 2012, American Educational Research Association: Vancouver, BC, Canada.
10. Keller, C., et al. *Research-based Practices for Effective Clicker Use*. in *2007 Physics Education Research Conference*. 2007. Greensboro, NC: American Institute of Physics.

11. Zhou, G. and I. Lyublinskaya, *The Use of Graphing Calculator Technologies for Learning and Teaching Science and Mathematics at Urban High Schools*, in *Society for Information Technology & Teacher Education International Conference 2008*, K. McFerrin, et al., Editors. 2008, AACE: Las Vegas, Nevada, USA. p. 4387-4391.
12. Cortés-Figueroa, J.E., D.A. Moore-Russo, and M.J. Schuman, *Using a CBL Unit, a Temperature Sensor, and a Graphing Calculator To Model the Kinetics of Consecutive First-Order Reactions as Safe In-Class Demonstrations.* Chemistry Education, 2006. **83**: p. 64.
13. Milner-Bolotin, M. and T. Antimirova. *Video Analysis in Science and Engineering Education.* in *EDULEARN10*. 2010. Barcelona, Spain: International Association of Technology, Education and Development (IATED).
14. Antimirova, T. and M. Milner-Bolotin, *Introduction to Video-Based Motion Analysis*, in *Canadian Association of Physicists Congress 2009*. 2009: Moncton, New Brunswick.
15. Thornton, R.K. and D.R. Sokoloff, *Real Time Physics: Active Learning Laboratory*. The Changing Role of Physics Departments in Modern Universities: Proceedings of ICUPE, ed. E.F. Redish and J.S. Rigden. 1997, College Park, MD, USA: The American Institute of Physics: p. 1101-1117.
16. Moll, R. and M. Milner-Bolotin, *The Effect of Interactive Lecture Experiments on Student Academic Achievement and Attitudes towards Physics.* Canadian Journal of Physics, 2009. **87**(8): p. 917-924.
17. Loverude, M.E., *A research-based interactive lecture demonstration on sinking and floating.* American Journal of Physics: Physics Education Research Section, 2009. **77**(10): p. 897-910.
18. Milner-Bolotin, M., A. Kotlicki, and G. Rieger, *Can Students Learn from Lecture Demonstrations: The Role and Place of Interactive Lecture Experiments in Large Introductory Science Courses.* Journal of College Science Teaching, 2007. **36**(4): p. 45-49.
19. Straits, W.J. and R.R. Wilke, *Interactive Demonstrations: Examples from Biology Lectures.* Journal of College Science Teaching, 2006. **XXXV**(4): p. 58-59.
20. Sokoloff, D.R. and R.K. Thornton, *Interactive Lecture Demonstrations: Active Learning in Introductory Physics*. Physics Suite. 2004: John Wiley and Sons, INC.
21. Milner-Bolotin, M., *Increasing Interactivity and Authenticity of Chemistry Instruction through Probeware and Other Technologies* Journal of Chemical Education, 2012. 89 (4): p.477-481.
22. Perkins, K., et al., *PhET: Interactive Simulations for Teaching and Learning Physics.* The Physics Teacher, 2006. **44**(January 2006): p. 18-23.
23. Wieman, C.E. and K.K. Perkins, *Commentary: A powerful tool for teaching science.* Nature Physics, 2006. **2**: p. 290 - 292.
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