

December 2010

## An Introduction to Ethical Considerations for Novices to Research in Teaching and Learning in Canada

Mark MacLean

*Department of Mathematics, University of British Columbia, maclean@math.ubc.ca*

Gary Poole

*University of British Columbia, gary.poole@ubc.ca*

Follow this and additional works at: [https://ir.lib.uwo.ca/cjsotl\\_rcacea](https://ir.lib.uwo.ca/cjsotl_rcacea)  
<http://dx.doi.org/10.5206/cjsotl-rcacea.2010.2.7>

---

### Recommended Citation

MacLean, M., & Poole, G. (2010). An Introduction to Ethical Considerations for Novices to Research in Teaching and Learning in Canada. *The Canadian Journal for the Scholarship of Teaching and Learning*, 1 (2). <http://dx.doi.org/10.5206/cjsotl-rcacea.2010.2.7>

---

# An Introduction to Ethical Considerations for Novices to Research in Teaching and Learning in Canada

## **Abstract**

Considering Canada's Tri-Council statement on the ethical conduct for research involving human subjects, we discuss some of the ethical challenges of doing research on teaching and learning in which one's own students and teaching act as the context of such scholarly activity. We advocate establishing basic principles based in the complex relationships in teaching and learning, making reference to the such issues as the potential social consequences for students of choosing not to participate in SoTL research. We propose some principles for those new to teaching and learning research to consider as part of their own ethical considerations.

En ce qui concerne l'Énoncé de politique des trois Conseils : Éthique de la recherche avec des êtres humains, nous présentons les difficultés déontologiques de la recherche sur l'enseignement et l'apprentissage au cours de laquelle nos propres étudiants et notre enseignement constituent le contexte de cette activité savante. Nous prônons l'établissement de principes fondamentaux basés sur les relations complexes entre l'enseignement et l'apprentissage et faisons référence à des enjeux comme les conséquences sociales potentielles du choix des étudiants de ne pas participer à la recherche sur l'ACEA. Nous proposons des principes que les chercheurs novices pourraient intégrer à leurs propres considérations déontologiques.

## **Keywords**

ethics, novices, social penalties, consent, guidelines, ethics review

## **Cover Page Footnote**

The authors thank the anonymous referees for their constructive comments. In particular, we thank the referee who referred us to Burman and Kleinsasser (2004). The present paper began in fall 2003 as a discussion between the authors during a research project of one of us (GP) that involved the class of the other (MM), and it was originally presented as a working paper for UBC's Institute for the Scholarship of Teaching and Learning and we are thankful to many colleagues with whom we have had engaging conversations about ethics that have enriched our understanding of the issues here presented.

There is an emerging focus on evidence-based improvements to teaching and learning in many Canadian universities. Faculty at these universities not only are looking for ways to measure the effectiveness of their own practices in the classroom, but, beyond that, to understand more deeply the fundamental pedagogies of their disciplines, pedagogies they have learned mostly through praxis. For example, the University of British Columbia (Vancouver) has recently funded the Carl Wieman Science Education Initiative (CWSEI) with the goal of achieving the most effective, evidence-based science education. The CWSEI works with science departments to establish what students should learn, to scientifically measure what students are actually learning, to adapt instructional methods and curriculum based on pedagogical research to achieve desired learning outcomes, and to adopt and disseminate what works (CWSEI, 2007). Faculty from outside of fields of educational research who engage in such work are usually novices in studying teaching and learning in their own disciplines in such a scholarly fashion. Our aim is to introduce such novices to some of the ethical challenges they will face and to seed their thinking so that they consider carefully how such research interacts with their broader responsibility to ensure an effective learning environment for their students. We are guided in our approach by the ethical standards for behavioural research outlined in the Tri-Council Policy Statement for ethical conduct for research involving humans (Tri-Council Policy Statement, 1998) and are aware that there is a developmental process by which such standards inform practical principles researchers may apply.

One of the goals of the scholarship of teaching and learning is to develop a coherent intellectual structure that acts as a framework for understanding how students learn and how teachers can best impact that learning. Although many aspects of such structures may be well studied in the higher education community, they are rarely known to novice teaching and learning researchers whose traditional research has been within the confines of their own discipline and not focused on its pedagogy and curriculum. As part of the development of such a structure, teacher-researchers necessarily will need to build research strategies and methodologies to study their students at the same time as they are acting as their teachers. That such scholarship is a natural part of the evolution of a discipline was well recognized by Boyer (1997) in his model of scholarship, in which teaching is a central element. Moreover, the natural communications of this scholarship through publications, seminars, and presentations make this scholarly activity public. Thus, teachers who act also as scholars of teaching and learning in the practice of their discipline must consider the ethics of their dual roles in situations in which their students are also their subjects of research. We agree with Hutchings's (2002) assertion that discussions of the ethical challenges involved in doing such work are not indications of an inherent problem with research on teaching and learning in higher education so much as of a developmental process. As Hutchings points out, in this process we rely on, and thus illuminate, our values as educators.

The potential value of the research embodying the scholarship of teaching and learning exists in tension with the ethical challenges of doing this work. This tension is relatively low when teachers engage in scholarly teaching in which they restrict their activities to such things as implementing an idea from the literature in their classrooms and then evaluating it using peer and student evaluations. The tension increases considerably when they choose to engage fully in the scholarship of teaching and

learning to study deeper questions about student learning and plan on sharing their research results publicly. On the one hand is the goal of improving student learning through the knowledge and insight gained from such research, and on the other hand is the degree to which the research program intrudes on the students' learning. For example, students may be asked to fill out surveys and to do extra testing throughout the term to provide data for the research project, and these extra demands may add significantly to the workload for a course. Added to this workload issue is the potential for students to feel coerced to participate because teachers may invoke their natural authority too readily or choose to make participation a part of the course grading scheme. Helen Dale describes the choices scholars of teaching and learning face as "not between good and evil, but between two goods. This creates dilemmas of fidelity" (Dale, 1996, p. 78). For example, there is a dilemma of fidelity faced if teachers choose to use marks to encourage participation in a survey: How do they include other activities in the course so that students who choose not to participate in their research projects have equal opportunities for extra marks? By working through these dilemmas of fidelity, researchers can reduce this tension so that their teaching and pedagogical research may be carried on together to the benefit of all.

For many novice scholars of teaching and learning, one of the initial research goals will be to build a toolbox of basic methods and strategies for creating viable and fruitful research projects, and ethical considerations need to have a primary role in these developments. For example, in a traditional controlled experiment, one sets up a control group in hopes of understanding the effects of a particular treatment or intervention. Beyond the difficulties of identifying an appropriate control group, this approach has a strong potential to impact on students' educational experiences and, since one rarely wants control groups that are voluntary, affects the educational choices a student may have. It is a serious question as to when this approach is appropriate, and the answer to this question will depend heavily on the degree to which the placing of a student in a treatment or control group would affect their learning. For example, at the University of British Columbia (Vancouver), researchers faced this difficulty when they sought to study the effectiveness of the Science One Program. Science One is a unique learning community in which first-year biology, chemistry, mathematics, and physics are taught in an integrative fashion in a classroom with a low student-to-faculty ratio (8 to 1). Thus, denying some students access to this program simply to make a control group was not deemed acceptable by its teachers since students in the control group would not have access to an equivalent educational opportunity. Wrestling with this ethical dilemma led researchers to develop a robust value-added analysis that did not require interfering with any individual student's educational experience (Dryden, Leander, Louis-Martinez, MacLean, & Waltham, 2009). Having ethics at the forefront in research design questions is critical given that a fundamental value in this research should be that we strive to be fair to our students with every decision we make regarding their educational experiences.

As novice researchers in teaching and learning consider how they will study their teaching and their students' learning and how such research may impact their students, they may wish to look at good examples of published scholarship of teaching and learning as a starting point. Although such works rarely discuss the explicit details of ethical reviews, it can be a valuable exercise to look at the research methods and protocols contained therein from the point of view of preparing a research proposal for an

ethics review, as this exercise necessarily prompts one to think about the ways in which the research could interact with students and student learning. One excellent annotated bibliography of scholarship of teaching and learning has been compiled by the CWSEI (2009).

### **Ethical Standards**

The teacher's responsibility to hold students' educational interests paramount provides an important perspective when considering ethical issues for research in teaching and learning. Teacher-researchers who intend to undertake a study of their students and publish the results will be faced with vetting their research proposals through an ethics review board. On the other hand, most classroom experiments in teaching may not be of interest to research ethics review boards, even if the teachers intend to talk about the results of such experiments within their departments or beyond. Wilson (2008) argues that such teaching activities are the purview of academic freedom and should not be subjected to reviews, although she does present the question of whether raising the value of such research to the same level as one's primary, in-discipline research raises the ethical standards. In practice, one might make the decision to submit to a full ethics review based on the level of intrusiveness into individual students' learning experiences needed to do the research or on the extent to which student work is used publicly. For example, Adams et al. (2006) present a validated instrument for measuring student attitudes about physics and learning physics. If other teacher-researchers now use this instrument to study the potential transformations of attitudes in their own classes as part of studying new teaching approaches, under what conditions should they submit their studies to ethics reviews? If their research involves looking only at class data as a whole or using students' work anonymously without presenting any individual's work publicly, it may be argued that as long as they are using generally accepted instruments or methods for their measurements, there is no need for an ethics review. However, if they develop a new instrument or method as part of their research, validating this instrument or method may involve interviewing students or looking at the details of students' work in relation to their responses on the survey, and this research likely would need a full ethics review. Furthermore, in research where the works of individual students were to be presented publicly, even if this were done anonymously, it is likely that the proposed research should undergo an ethics review. Novice researchers may wish to consult with the chairs of their institutions' ethics review boards for guidance on whether or not their proposed research would require an ethics review.

The responsibility of teachers to provide safe and effective learning environments for students provides an impetus to have strong ethical standards by which to judge both scholarly teaching and the scholarship of teaching and learning. As a starting point to help us to interpret current ethical standards in Canada for behavioural research as they might apply to research on teaching and learning, we turn to the standards set by the Tri-Council Granting Agencies (CIHR, SSHRC, and NSERC), which are main public research granting agencies in Canada. These standards are outlined in the Tri-Council Policy Statement on "Ethical Conduct for Research Involving Humans" issued by the three major research councils of Canada in 1998 (Tri-Council Policy Statement, 1998), and the responsibility for ensuring that individual researchers follow these standards falls to ethics boards in individual institutions. To a great degree, however, the intended use of

the research results and the degree of intrusiveness of the research methods are used by institutions to determine whether or not a research proposal to study teaching and learning must undergo an ethics review. We note that some institutions will distinguish between “institutional research” on teaching and learning, which is done entirely to inform the university privately as to the effectiveness of its teaching and learning activities, and “public scholarship of teaching and learning,” which is intended to be published or otherwise disseminated publicly. In the former case, some institutions require limited or no ethics reviews, while research of the latter category would be subject to a full review. An example of “institutional research” would be a study of student performance in upper year courses that examines the relationships with performances in two first-year courses that use different teaching approaches. Since this study could be carried out without the researchers knowing the identities of the students involved or without researchers interacting with the students, and since the results might be used only by a department to decide which of the two teaching approaches is more effective, no ethics review would be required at most institutions. Such a study might be shared through publication or presentation at a conference and still not require an ethics review. However, if teacher-researchers intend to publish research comparing the effects of two teaching approaches that involves interviewing students or using student work as data, for example, then an ethics review likely would be required for this “public scholarship of teaching and learning.”

Ethics review boards evaluate research proposals involving human subjects with a mind to protecting the rights of participants. Two of the key elements in their evaluation are as follows:

1. Are participants given the opportunity to give free and informed consent, without manipulation, undue influence, or coercion? (Article 2.2 of the Tri-Council policy statement)

2. Is the right to privacy of the participants respected in the research design, in the use of the data collected, and in the proposed dissemination of the results of the research? (Article 3.2 of the Tri-Council policy statement)

These questions provide a starting point to explore key ethical challenges in doing pedagogic research in the context of our own teaching; however, there are important complications that arise from such research that need to be considered.

### **Informed Consent and Social Penalties**

Informed consent is complex when our students are involved in our research. By engaging in research in teaching and learning in our classes, we add new stresses to the power dynamics of the teacher-student relationships by creating a situation in which we expect to benefit from these relationships; we may alter the learning environment by engaging in activities designed around our research questions; and we change the manner in which students’ work will be used by creating secondary analysis of it for our research, and hence change the way students perceive their work and our evaluation of that work. Burman and Kleinsasser (2004) present nine principles to guide the use of student work in the scholarship of teaching and learning. Their suggestions for implementing these principles highlight the value to both the students and researchers of including students in the research design process from the beginning. They also emphasize the need to respect

students' work in this process. We impinge on the students' experiences as learners when we engage in such research by changing the expectations for everyone involved. In many cases these changes are intentional. The problem is that we do not know precisely what these effects will be. (It may be the part of the research to discover these effects.) For example, if we ask a student to keep a journal about his or her learning experiences, how long will this take? How can we help students learn to write such a journal so that it provides meaningful data while at the same time provides them with a learning experience true to the discipline they are studying? We are led to ask: How do we ask for "informed consent" when we truly cannot inform the students about all the ways this research might impact them? We need to address this uncertainty in the consent process, but without sending the message that the researcher does not know what he or she is doing or that the research is anything less than what responsible academics do and what students and faculty alike should embrace.

The issue of informed consent underscores the tension between the potential value of research in teaching and learning and its obtrusiveness. A similar tension exists between the desire to encourage students to take the time to participate and what we might call "social penalties" for choosing not to participate. On the one hand, students need to be made aware of the potential benefits of research if they are to devote their valuable limited time to it. This can be accomplished by including students in the design phase of the research project, by holding an open discussion about the research and its goals with the students in the class, and by sharing the results of the research with them. On the other hand, we have seen that the Tri-Council policy statement on such research makes it clear that there be no unethical use of authority to coerce participation. Attempts to recruit students must be sensitive to the balance between extolling the potential virtues of a project and the coercion in authority-based appeals. One mechanism of reducing the impact of a teacher's authority in the appeal is to introduce a coresearcher who is not directly teaching or assessing the students. For example, the CWSEI provides Science Teaching and Learning Fellows (STLFs) to assist faculty in their research on teaching and learning. In this model, STLFs can host a discussion with the class about participation and opting out, and they can provide a means by which teachers are blind to which students are participating in the research and which are not.

What do we mean by "social penalties"? Essentially, we are referring to the potential ostracism and stigmatization that can result from choosing to opt out of a study. Such negative responses could come from peers or from the teacher, and both cases have the potential to strongly impact a student's learning experience. For example, students who have chosen to participate in the research may choose to exclude those who have not from classroom working groups since the participating students may feel that their participation in the research means their work will be valued more by the teacher-researcher and hence earn them a better grade in the course. Care must be taken to create research designs that minimize these social penalties. For example, if students are asked to complete a survey in class, all students' surveys should be folded and handed in, completed or not.

Minimizing social penalties may be more complicated if, instead of using a separate tool like a survey that is somewhat independent of the learning process, the research design makes use of students' actual work, monitors directly students' activities, or involves interviewing students while they are taking a course. In many cases, we

would use students' work as data, which is not its primary purpose. Social penalties could manifest if a student feels the teacher would assess the student's work differently based on whether or not the student were a research participant. One way to approach this problem is to make sure that the research-related analysis of students' work happens after a course is completed and marks are finalized. As well, as Burman and Kleinsasser (2004) and others suggest, consent forms could be sealed and the researcher would be blind to which students are participating. While this may be appropriate for some situations, we would not advocate making such blind consent a requirement.

Our role as teachers comes with the responsibility to ensure that our classes are safe places to learn. Trust is an essential element in building a sense of safety, and it is important that we work to create and maintain a high level of trust in our classes. (By *trust*, we mean a willingness to risk being vulnerable.) This trust, moreover, is also a powerful factor in helping us to engage students in research about our teaching and their learning, so much so that it should be considered from the beginning in the research design process. We agree with Burman and Kleinsasser (2004) that involving students in the research design process would be valuable in ensuring the design takes into account student concerns. In the least, opening a discussion with them about the goals of the research and how it would affect them helps to create the essential trusting relationships.

Frank discussions with students will help eliminate social penalties. Teacher-researchers generally should discuss their own role in the research and their positions of authority in the class as a potential conflict in that research. Engaging in ongoing dialogue with the students throughout the course about the research and how it is affecting the students' educational experiences increases the students' comfort with the research and allows them to continue their decisions to give "informed consent" as truly informed participants.

While part of the conversation with students about the research can be public, it is critical that students are able to give/not give their consent through as private a process as possible. Some methods can make this difficult. A research protocol that involves making audio or video recordings of students (often yielding very useful data) is a prime example. If some students wish not to be recorded, asking them not to speak during the class or to sit on the periphery to avoid being recorded makes very public their choice not to participate in the research and also limits their participation in the class, which has the potential to impact negatively their classroom experiences. Some ethics review boards discourage such solutions given this potential for a negative impact on the students' learning. Ethics review boards should give research proposing to record student activities in the classroom a full and detailed review. Other methods that would identify publicly students who are nonparticipants should similarly be given careful consideration. Naturally, researchers should include in their research proposals a discussion of the steps they will take to minimize the intrusiveness of their research protocols on the learning experiences of their students.

### **The Potential to Impact Learning While Studying Teaching and Learning**

In considering research designs that might also benefit students' learning, an interesting approach is captured in the question: Can we create "learning tools" that are based in the activities a student is expected to master and that also give insight into how



they learn? For example, students in mathematics or science spend a good deal of their time learning the quantitative methods that underlie these fields. To find activities which give us insight into the modes of learning needed to master mathematical thinking while at the same time help students master requisite skills would be powerful indeed. At once, we imagine these tools to be ultimately invasive by allowing us to see student learning as it happens, but with the benefit that the tools themselves positively impact learning. With such tools, all students benefit regardless of whether or not they are participants in the research and one can extract useful data without revealing publicly which students are participating. Well-designed computer interactions are one medium for building such tools (Wieman, Adams, & Perkins, 2008), and classroom response systems (“clickers”) are another effective tool for exploring students’ learning in the classroom (Smith et al., 2009). “Think aloud” interviewing techniques can provide the basis for seeing how a student thinks (Ericsson & Simon, 1998); for example, the teacher-researcher can ask a student to solve a problem on the board and to explain aloud each step they are taking. This gives great insight into a student’s understanding (and has been used effectively by one of the authors to help students in mathematics) and so is an effective tool to use in analyzing how students learn.

As we previously noted, using students’ work as data raises its own ethical challenges. As Burman and Kleinsasser (2004) note, this is particularly true if samples of poor or “inadequate” work are to be used as examples in research publications or seminars. Most ethics review boards insist on anonymity as a condition for presenting students’ work publicly. However, if this work is shared with the student-subjects of the research, as might be advocated as a natural part of ensuring the research benefits participants directly, what of students who recognize their own work in the presentation? Students whose “inadequate” work is so publicly on display may experience a different kind of social penalty, one associated with participation: a private feeling of embarrassment or a reduction in self-esteem. Researchers should consider carefully how they will communicate with these students as part of the “informed consent” process. The goal in this instance should be to minimize any such negative impacts on individual students. Open and trusting communication can turn these situations into individual learning opportunities for these students, demonstrating an immediate benefit of the research on the learner-participants. Indeed, this feedback process might be a part of the presentation of the research results by showing any inadequate work in the context of the students’ learning progress.

By including students in such integral ways in our discussions about the research we conduct on their learning, we may come to view our students as partners in this pedagogic research. Hutchings (2003, p. 32) notes that faculty often find it “off-putting to refer to students as ‘research subjects’” and introduces the idea that “the scholarship of teaching and learning may be seen as a cousin to the undergraduate research movement.” This perspective has the advantage that it brings up the question of how students themselves would benefit from being participants in pedagogic research. In particular, there is interplay between the research methods and the goals for students’ learning. By having students as active partners in this research, we ensure that their interests are protected and that these interests are always at the forefront. Moreover, we believe that wrestling with the ethical issues that arise in bringing students into pedagogic research as

partners will help us to design appropriate and powerful methods for understanding their learning and our roles in that learning.

Thus, there are many potentially interesting ways in which research in teaching and learning may interact with the teaching and learning themselves. This is exciting since exploring these interactions can lead to more effective teaching, better student learning, and to a better understanding of how to approach the scholarship of teaching and learning. This critical loop, including both practice and a serious study of the effects of that practice, does raise ethical challenges, but wrestling with these surely will deepen our understanding of teaching and learning. Indeed, some argue that this scholarship is essential for universities to properly realize their educational mandate (McKinney, 2004).

### **Creating Ethical Guidelines**

As faculty from many diverse fields, especially those distant from human behavioural research, undertake this scholarship of teaching and learning, perhaps the first big challenge will be to find a working set of ethical principles on which to base their research. We urge these potential scholars of teaching and learning to consider the following:

1. Present the potential costs and benefits to students frankly, making explicit reference to one's position of authority where appropriate, and acknowledging the degree of uncertainty regarding the full range of impact on students' educational experiences.
2. Ensure that the "social penalties" arising from the choice to participate or not participate are minimized, if not eliminated, by reducing the public nature of the decision not to participate and by assuring students that there will be no adverse consequences to not participating.
3. Make every effort to design methods that enrich students' educational experiences rather than detract from them.
4. Disseminate the results in ways that protect student identity while also maximizing the benefit of the study for practice.

Hutchings suggests that "what is needed most is not, then, a set of rules but a process of reflection, self-questioning, and discussion" (2002, p. 2). While we agree that such reflection is essential to establishing the basic principles for ethical research with student participants, the constructive evolution of guidelines for ethical research based on these principles requires more than reflection. This is well illustrated, for example, in the principles for using student work as research data presented by Burman and Kleinsasser (2004). We are required to ensure compliance with ethical standards such as those applied by the Tri-Council Granting Agencies, and so our ethics review boards must deal with the practicalities of assessing research proposals against such standards. Scholars of teaching and learning should play an active role in the efforts to articulate and implement these standards within their own institutions.

## Conclusion

The potential value of research in teaching and learning to benefit students is sufficient to warrant the work required to build the framework and context needed to understand how students learn and how our teaching affects that learning. At some level, the ethical dilemmas teacher-researchers face in doing research in teaching and learning reflect the richness and diversity of learning situations in our institutions. Thus, these ethical challenges should be viewed as opportunities to examine the critical relationships between teachers and students and how they affect learning. In a very real way, understanding these relationships is central to this scholarship.

## References

- Adams, W. K., Perkins, K. K., Podolefsky, N. S., Dubson, N., Finkelstein, N. D., & Wieman, C. E. (2006). New instrument for measuring student beliefs about physics and learning physics: The Colorado Learning Attitudes about Science survey. *Physical Review Special Topics – Physics Education Research*, 2, 1–14. <http://dx.doi.org/10.1103/PhysRevSTPER.2.010101>
- Boyer, E. L. (1997). *Scholarship reconsidered: Priorities of the professoriate*. San Francisco, CA: Jossey-Bass.
- Burman, M. E., & Kleinsasser, A. (2004). Ethical guidelines for use of student work: Moving from teaching's invisibility to inquiry's visibility in the scholarship of teaching and learning. *The Journal of General Education*, 53(1), 59–79. <http://dx.doi.org/10.1353/jge.2004.0018>
- Carl Wieman Science Education Initiative main website. (2007). <http://www.cwsei.ubc.ca> (Accessed 30 April 2010).
- Carl Wieman Science Education Initiative recommended papers. (2009). <http://www.cwsei.ubc.ca/resources/papers.htm> (Accessed 3 June 2010).
- Dale, H. (1996). Dilemmas of fidelity: Qualitative research in the classroom. In P. Mortensen & G. E. Kirsch (Eds.), *Ethics and representation in qualitative studies of literacy*. Urbana, IL: National Council of Teachers of English.
- Dryden, N., Leander, C., Louis-Martinez, D., MacLean, M. & Waltham, C. (2009). *Are we doing any good? A value-added analysis of the University of British Columbia's Science One Program*, preprint.
- Ericsson, K. A., & Simon, H. A. (1998). How to study thinking in everyday life: Contrasting think-aloud protocols with descriptions and explanations of thinking. *Mind, Culture, and Activity*, 5(3), 176–186. [http://dx.doi.org/10.1207/s15327884mca0503\\_3](http://dx.doi.org/10.1207/s15327884mca0503_3)
- Hutchings, P. (2002). *An introduction to ethics of inquiry: Issues in the scholarship of teaching and learning*. Menlo Park, CA: Carnegie.
- Hutchings, P. (2003). Competing goods: Ethical issues in the scholarship of teaching and learning. *Change*, 35(5), 26–33. <http://dx.doi.org/10.1080/00091380309604116>
- McKinney, K. (2004). The scholarship of teaching and learning: Past lessons, current challenges, and future visions. *To Improve the Academy*, 22, 3–19.

Smith, M. K., Wood, W. B., Adams, W. K., Wieman, C., Knight, J. K., Guild, N., & Su, T. T. (2009). Why peer discussion improves student performance on in-class concept questions. *Science*, 323(5910), 122–124.

<http://dx.doi.org/10.1126/science.1165919>

*Tri-Council policy statement: Ethical conduct for research involving human subjects.* (1998). [http://www.ncehr-cnerh.org/english/code\\_2/](http://www.ncehr-cnerh.org/english/code_2/) (Accessed 1 June 2006).

Wieman, C. E., Adams, W. K., & Perkins, K. K. (2008). PhET: Simulations that enhance learning. *Science*, 322, 682-683. <http://dx.doi.org/10.1126/science.1161948>

Wilson, J. H. (2008). The value and ethics of the scholarship of teaching and learning. In S. A. Meyers & J. R. Stowell (Eds.), *Essays from excellence in teaching* (Vol 8). Society for the Teaching of Psychology.

<http://www.teachpsych.org/resources/e-books/eit2008/eit08-04.pdf> (Accessed 1 May 2010).