

Regulations and Ethical Considerations for Working with Human Participants in Physics and Astronomy Education Research

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Abstract:

Physics and astronomy education research (PAER) relies upon human beings. While this statement may seem self-obvious, this reliance brings with it many ethical and legal implications. In the United States, various federal laws and foundation statutes require that before any research begins, someone has reviewed the research protocols to ensure the protection of the research subjects. This task frequently falls to an Institutional Review Board. This article will introduce the troubling history that led to the federally protected rights of research subjects and how institutions safeguard those rights. As an education researcher you are

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responsible for protecting those rights and this article will introduce you to the help that is available to get you through the morass of regulations. Finally, the article ends with a few case studies to highlight the ethical and legal issues in PAER.

1. Introduction

At your institution, you may find that there exists a culture of wariness with regard to Institutional Review Board (IRB) oversight of physics education research (PER). A summary of the views of PER professionals at a 2006 Physics Education Research Conference (PERC) workshop on human subjects issues found that some of us believe that consent forms do nothing more than cause needless anxiety, and that “PER does not raise issues of confidentiality, liability, or unfairness in comparison to the ‘standard’ instruction.”¹ Following from these sentiments, many of our colleagues have come to see preparing for IRB approval as an overly time-consuming burden on their work. These feelings notwithstanding, doing PER without oversight is not only unethical, it is also illegal, and can land the researcher, and his or her institution, in some potentially very hot legal waters.

To be sure, compared to medical and even psychological research, the risk to participants seems minimal. However, this is an unfair comparison; from the participants’ point of view, the level of risk is not assessed as compared to other kinds of research, but as compared to their everyday activities, which in the case of physics education research is probably *learning*. By this standard, any kind of research has the potential to put participants at risk, and the persistence of the belief that education research has NO risk has made many of us sloppy with regard to our research ethics. As educational researchers Howe & Moses have written, “Although moral abominations in social research are rare, other pressures – for instance, pressures to ‘publish or perish’ – are real and ubiquitous, and one need not be a bad person to be tempted to cut ethical corners in response to them, especially if cutting corners is the norm. Furthermore, one need not be a bad person to be unaware of ethical worries that others are able to detect, particularly others [such as the staff of Institutional Review Boards] who have a good deal of experience with the pertinent issues.”²

Is it wrong for us to grumble about having to spend time preparing a project review form for an IRB? No, of course not. Then is it okay to

ignore, evade, or work around the IRB and conduct our research without oversight? No, of course not. The reasons for this resounding “no” are several, and will be discussed thoroughly in this article, but the foremost among them is this: we invest this time and effort not for ourselves, not for our IRBs, but for our learners.

As a community of education researchers, we already know that we care about physics learners and the improvement of their educational experience. This same concern for learners should be apparent in our research ethics as well. Whether we are instructing undergraduate students, developing curriculum, creating exhibits, or evaluating programs, the individuals involved in our research come to us not to take part in our studies, but to learn from us. The priority for educational research must be providing every student with a quality educational experience, and not sacrificing their learning for the sake of our research. The considerations we make with regard to the ethical and responsible conduct of our research is ever for the benefit of those who put their faith in us when they willingly participate in our research. Maintaining our focus on the just treatment of these learners helps us to keep our efforts in perspective.

The responsible conduct of research is a foundational principle of the scientific professions. Professional societies like the American Physical Society have created documents outlining professional conduct within the field.³ You may have taught ethics to students, implicitly or even explicitly, when explaining the standards of the field of science, such as not plagiarizing or fabricating/misrepresenting data; there is a whole journal (*Science & Engineering Ethics*) dedicated to ethical concerns in science and engineering.

Ethical standards are a concern in education research as well. Professional science societies frequently establish codes of ethics in order to encourage their memberships to uphold the standards of the societies’ work. As a field where studies can involve the young and vulnerable, education research also has a detailed code of ethics. The American Educational Research Association, the largest organization of educational researchers in the United States, has an extensive set of ethical standards to which its members adhere. These standards address not only authorship, conflicts of interest, and the publication of research results, but also the responsibilities of researchers toward their study participants.⁴

It is this latter responsibility on which this article focuses. In addition to the ethical standards of the field of education, there are U.S. federal government regulations, which have the power of administrative law, that govern research with human participants. PER, as a hybrid field of study, has many practitioners who have come from the field of physics, where one rarely deals with human participants. It is thus not uncommon to be unaware of these federal regulations and the code of conduct upheld by professional education research societies. Yet, as physics education researchers, we have to be aware of the moral and legal duties of our profession. In this article, the regulations and ethical considerations will be explored in detail, with the emphasis on the practical application to research projects.

In the next section, we briefly discuss the historical background of the oversight of research with human participants, leading into the federal guidelines and the installation of Institutional Review Boards (IRB). We then discuss how the IRB works and how to ensure that research proposals conform to the standards set by the federal guidelines. In the final section, we discuss potential ethical pitfalls in PER and ways to avoid them.

2. Historical Background

Generally, there is only a need to establish laws when individuals' behaviors are misaligned with society's ethical standards. Though society expects researchers to respect the rights and concerns of their human participants, sadly this expectation has not always been met. Following the Nuremberg War Criminal Trials, the Nuremberg Code of 1947 established the minimum standards of medical ethics in Europe. Within the United States, the infamous Tuskegee Syphilis Study administered by the United States Public Health Service from 1932 until 1972 prompted the initiation of the 1974 National Research Act. This act created, by act of Congress, a commission to establish ethical standards for biomedical and behavioral science.

The National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, the commission established by the National Research Act, subsequently published the Belmont Report.⁵ In 1991, the majority of federal agencies which support or conduct research accepted the Belmont Report as their guidelines. The Belmont Report can be distilled into three central ethical principles: (1) respect for persons, (2) beneficence, and (3) justice.

Respect for persons refers to the recognition of the autonomy of the person, both when the subject has autonomy and when that autonomy is compromised, for instance by the person's age, mental disability, or status as a prisoner. Autonomy is defined in the Belmont Report as the capacity of "deliberation about personal goals and of acting under the direction of such deliberation."⁵ Students, particularly those that are minors, may have compromised autonomy by virtue of the fact that they are dependent on their instructors for their grades and cannot decline to do what their instructor tells them for fear of jeopardizing their academic status. *Beneficence* is akin to the medical maxim of "do no harm." It is important to avoid injuring the research participant, not only physically but also emotionally, psychologically, and academically. The researcher must mitigate risks to the participant while maximizing benefits, to the participant and to the larger society. *Justice* balances the burden of participation in the research with equal access to the findings and benefits derived from it. Given the history of abuse in the name of science against those who could not otherwise object, the principle of justice requires the researcher to ensure that when research subjects from protected classes are used, that those same classes of subjects derive a benefit from the study: their lives should improve.

The standards outlined in the Belmont Report were integrated into the U.S. Department of Health and Human Services' Code of Federal Regulations under "Protection of Human Subjects," which has the authority of administrative law.⁶ For institutions receiving federal funds for research with human participants, the oversight of the implementation of these regulations is the purview of Institutional Review Boards (IRBs), the role of which is discussed in detail in the next section. It should be noted that the rules and regulations outlined below apply only to the United States. Other countries have different laws, guidelines and requirements.

3. The role of the IRB

Every U.S. institution that receives federal money to do socio-behavioral or biomedical research is required to have an Institutional Review Board (IRB), which reviews research proposals to determine the risk to participants. All research personnel affiliated with such an institution fall within the IRB's jurisdiction, even if they themselves do not receive

federal monies for their research. An educational researcher cannot start a study until approval from his or her IRB is obtained.

The first decision you have to make as a researcher is whether you intend to publish or publicize results obtained from data related to human participants. No IRB approval is required for course evaluations, assessments, and the like. However, as soon as you want to go public with your results in any shape or form, IRB approval for your study is required.

The second determination to make is what kind of research oversight you have at your institution. Schools, school districts, Native American tribes, community colleges and universities all have slightly different systems in place to suit their particular needs. These systems have different requirements for researchers. It is very worthwhile to sit down with your IRB representative to figure out the institutional requirements. He or she can tell you what your institution's requirements are for research with human subjects, which typically involves some form of certification. He or she can also tell you about the requirements a research proposal has to address, as that can vary from institution to institution as well.⁷ In the next section, we outline the common elements of such a research proposal.

Research involving many institutions has additional burdens. It is not the case that the researchers accept the IRB recommendation with the lowest standards for the project, rather researchers need to meet *all* of the IRB requirements. Frequently IRBs from different institutions will enter into a legally binding agreement allowing one of the IRBs to review compliance for all of the institutions.

3.1 Common elements in a research proposal

A research proposal for the IRB has three common elements that need to be addressed. Individual institutions may have additional requirements. In the proposal, you need to discuss the procedures you have in place with regards to recruitment, consent, and confidentiality. In each of these sections, you need to make clear that you have taken precautions to minimize the risk to participants.

Recruitment

As noted before, a study has to be approved by the IRB before you are allowed to do anything, including the recruitment of participants. Recruitment procedures need to outline who potential participants can be, how they will be approached, possible incentives to participate, and how

you will ensure that participants are aware that their participation is voluntary. This latter part is especially important when doing research on your own students. Students can feel pressured to participate in a study if it is their instructor who is doing the research, as the instructor has control over the grades, and they may not know what the consequences will be for not participating. Hence, clear procedures are needed especially in that case so that students do not feel pressured to participate and will not be penalized for not participating.

Informed Consent

The second issue the IRB will want to know is how informed consent is obtained from the participants. Consent to participate in the research is given by the participant, and if necessary his/her legal guardian, on the basis of the risks, costs, and benefits to that participant.² A fair assessment of these factors is only possible if the participants are provided with all relevant information about the study and their potential role in it, which requires full disclosure on the part of the researcher. The researcher must divulge the purposes of the research, what a participant will be expected to do, the kinds of information that will be gathered, how participants' information and privacy will be protected, any risks and benefits to the participant, a statement about the authority of the individual to decline to participate and, if they do consent to participate, a statement about their ability to withdraw from the study at any time without repercussion. Information about whom to contact if potential participants have any concerns or questions about the research should also be provided

Informed consent is typically obtained in writing, where the participant signs a statement indicating awareness that the data he or she is about to provide will be used for research purposes. Note that this includes photographs, video, or audio data of students as well. In some cases, such a written statement can be waived at the discretion of the IRB, for example in the case of an anonymous questionnaire, where instead of a written consent form, a disclaimer can be used stating that filling in the questionnaire will be considered consent to use the data for research purposes. However, this can vary from institution to institution and in all cases, it is the IRB, not the researcher, which determines the level of consent required.

Basics of Consent Form.

Brogt, Dokter, and Antonellis⁸ present the elements that are listed in the federal regulations concerning consent forms,⁶ which can be used as a basis for a consent form, though institutions may have a template consent

form as well, so you do not have to build one from scratch. The elements are:

- a statement that the study involves research, an explanation of the purposes of the research and the expected duration of the subject's participation, a description of the procedures to be followed, and identification of any procedures which are experimental
- a description of any reasonably foreseeable risks or discomforts to the subject
- a description of any benefits to the subject or to others which may reasonably be expected from the research
- a disclosure of appropriate alternative procedures or courses of treatment, if any, that might be advantageous to the subject
- a statement describing the extent, if any, to which confidentiality of records identifying the subject will be maintained
- for research involving more than minimal risk, explanations as to whether any compensation and/or any medical treatments are available if injury occurs and, if so, what they consist of, or where further information may be obtained
- an explanation of whom to contact for answers to pertinent questions about the research and research subjects' rights, and whom to contact in the event of a research-related injury to the subject
- a statement that participation is voluntary, refusal to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled, and the subject may discontinue participation at any time without penalty or loss of benefits to which the subject is otherwise entitled

A special note should be made about working with minors. People under the age of 18 are not legally able to give consent. Instead, a parent or legal guardian has to give permission for the minor's data to be used for research purposes. In addition, the minor has to give assent as well. Assent is affirmative agreement to participate in the research, the specifics of which will depend on the age and cognitive level of the child.⁶ Minors are a protected population under the law, as they are considered to be at increased vulnerability to coercion. Researchers must also check with the school administration before beginning work in a K-12 setting.

Confidentiality & Privacy

A third part of the research proposal to IRBs deals with confidentiality and privacy. Participants have a right that their privacy be respected and their data handled in a confidential and conscientious manner. Depending on your institution's policies, you may need to specify who can gather data, who has access to it, and who is authorized to work with it. As a matter of privacy, only these individuals are entitled to know who is participating in the study and which data belongs to a given participant. The data must be kept confidential. For example, at the institutions of the first four authors, this means that paper data (transcripts of interviews, written surveys, etc.) must be kept under lock and key, and electronic data should be on a secure, password-protected computer. It also means that researchers should not name participants in conversations held in public settings, where they may be overheard. In general, as risk to participants increases, data security should likewise increase.

Videodata requires a special level of confidentiality. While lots of rich and meaningful interpretations may be drawn from a video of student interviews or a class interacting, unless the individuals involved have explicitly granted permission for public display of their interview or class (which frequently requires another permission form separate from a consent form), researchers cannot show this data to anyone other than those listed on the IRB research proposal application. Therefore, videodata generally cannot be shown at conferences or pictures used in publications.

In addition, data obtained for one purpose cannot be used for other research studies without re-approval from the IRB. Participants volunteered their data for one particular study, and each subsequent study has to pass IRB review again in order to determine the risk to participants.

A special case of confidentiality occurs when dealing with students. In that case, one does not only need to take the federal rules and regulations with regards to research on human participants in consideration, but also the federal Family Educational Rights and Privacy Act.⁹ We discuss this act in one of the subsequent sections.

4. What if your institution does not have an IRB?

Strictly speaking, federal requirements do not pertain to institutions that do not receive federal funding to conduct biomedical/behavioral research, such as some community colleges and K-12 schools. As professionals;

however, all researchers should adhere to these standards. As a growing and maturing research community, it is beneficial to have a single standard by which to assess the ethics underlying a research project. The easiest way to do this is for all researchers to abide by the federal regulations and principles of the Belmont Report. A better, although not free, way to meet human subject compliance is to hire an independent IRB company to ensure your ethical practice and research design. Such companies can be easily found with a web search.

5. Outcomes of IRB review

The IRB will return one of three findings endorsing the research proposal. *Exempt* is the most common finding in PER or other research which is minimally invasive. Here the IRB considers the proposal and classifies it as exempt. Exempt means that the research does not need further investigation or continual oversight. The IRB might require a consent form or additional documentation. The most important fact to remember is the IRB makes the decision for exempt status, not the researchers.

Expedited Review involves a more thorough review of the proposal and is common when protected classes of subjects or extensive interventions are a part of the research proposal. In these cases it is incumbent upon the researchers to keep the IRB informed and to follow the IRB recommendations carefully. If researchers suspect they might be headed for expedited review, they should start working with their IRB as soon as possible. *Full Review* is an outcome almost exclusively reserved for medical or animal experiments.

Termination is also the right of an IRB. If a research study (even if previously approved) violates federal law, the IRB can stop the study. Likewise, the IRB does not need to approve a research proposal. In such cases, if the study has merit, the IRB will generally have recommendations for the researchers on how to get their project approved.

6. FERPA

In addition to the rules set forth by the federal regulations and the Institutional Review Board, researchers in the U.S. working with students need to follow the privacy rules outlined in the Family Educational Rights and Privacy Act (FERPA).⁹ This federal law governs the use of students'

educational records and personal information. Most educators are familiar with at least one aspect of this act, in the sense that it is not permissible to use students' names, student identification numbers or social security numbers to post grades. Names, addresses, social security numbers and the like are all considered personally identifiable (either directly or indirectly) and the law restricts the number of people who can have access to this data and to students' educational records (grades, GPA, etc.). In virtually all circumstances, written consent needs to be obtained to use this information. The law allows for certain exceptions in cases of emergency, but those are not germane for educational research purposes. Consent is obtained either from the parents of the student, if the student is a minor, or from the student him or herself if the student is either over 18 or attending tertiary education.

In research studies, it is often very useful to collect student identifiers, for example when you want to match assessment data pre and post-instruction. However, matching data can be done by assigning pseudonyms, numbers, or other unique, but not personally identifiable, identifiers to participating students, meaning there may be no need to ask for student names or identification numbers. The bottom line is that the less personal information you gather from the students, the better.

FERPA applies to asking for demographic information. Many surveys in science education ask, almost as if by default, for demographic information. This is a worrying trend as demographic information is inherently personal. Therefore, unless you have a good and valid reason to ask for this information, and need it for your research, you should not ask for it. Getting the information to "see if something correlates" with, for example, gender or race is what psychometricians refer to as a "phishing expedition" where you capitalize on random chance to find significant results (if you do 20 measurements at the .05 level, chances are that you will find at least one significant result). Hence, it is good practice, both ethically and methodologically, to only ask for the information you need to help answer your research questions.

A special case is where research is done on one's own students. FERPA allows persons with a "legitimate educational interest" to have access to student records without a student's consent. The law does not specify further what is meant by "legitimate educational interest" and the definition can vary from institution to institution. Typically, as an instructor of a class, you have such a legitimate interest, for example to see how one of your struggling students is doing in his or her other

classes, to ascertain if there may be a deeper problem. However, as is argued elsewhere in this article, your responsibilities as an instructor should always take precedence over your research agenda in your classroom. This means here that certain information to which you have access as an instructor without student consent is off-limits to you as a researcher. If you want that information, you will have to get consent from the students. For example, if you wanted to correlate performance in your class to students' GPA (whether that is useful research to pursue is a whole other matter), as an instructor you may have access to the students' educational records and their grade point averages. However, simply pulling the GPAs of your students without their consent to do your research does not qualify as a "legitimate educational interest." (It is not in the interest of your students but simply serves to aid your research.) As such, it is both a violation of 45 CFR 46 with regards to the requirements of informed consent of participants and a violation of FERPA with regards to the use of student records.

7. Scenarios¹⁰

Conducting educational research is vital to the creation of curriculum materials, building and testing learning theories, and for the intellectual endeavor of the science. The recommendation of the Belmont Report and the legal protection provided under FERPA do not necessarily stop educational research. As has already been mentioned, IRBs are allies in designing and implementing research studies. Even without this resource, ethical research can be conducted. The following two scenarios are meant to illustrate ethical research.

Scenario - College	Interpretation
<p>You are planning to teach two sections of introductory physics class for science and engineering majors next semester. You have been considering the use of online, applet-based homework assignments rather than the paper-based end-of-chapter homework sets you have assigned in the past. However, you are unsure about the student learning outcomes for online homework assignments. For that matter, you are curious what students are learning from the</p>	<p>You cannot purposefully give students a treatment that you know will not be as effective as other methods. Since you are not sure which one is the best method in this case, you are within ethical bounds.</p>

<p>homework sets. After talking with several colleagues about this dilemma and conducting a literature review of the available work in PER, there still does not seem to be a clear “winner.” Therefore, you and a PER colleague at another university, along with your two PER graduate students, decide to conduct a research study with the two sections of the class in order to determine what students learn from each of these homework approaches.</p> <p>In order to narrow the scope of the study, you decide to focus on concepts related to forces and Newtonian mechanics. Your research question reads, “What do students learn about Newtonian mechanics from applet-based, online homework assignments, and how does this compare with traditional end-of-chapter problem set assignments?” In order to answer the research question, you decide to utilize a mixed-methods research design, combining quantitative data from the Force Concept Inventory before and after the Newtonian mechanics unit, as well as qualitative data from open-ended questionnaires and interviews using think-aloud prompts with a small sample of students while they are solving problems during that unit.</p> <p>In class, you have been audio-recording your lectures using software that simultaneously records what is on the computer screen, and posting these on the course website. Your graduate students suggested that this technology be used in the interviews with students completing the online homework. Therefore, you will be trying out the use of this software as a research tool in this particular study as well.</p> <p>All four members of your research team have conducted research in physics education in the past, and have passed the necessary requirements to conduct human subjects research at your respective institutions. Your team begins preparing the necessary paperwork</p>	<p>A mixed method design can yield valuable additional information in this study. However, deciding who to interview can present some problems. How will you recruit your participants; is there a reward structure? Note that you cannot offer participants extra credit if such an option is not available for non-participants.</p> <p>Note that you cannot record anything from your students without consent. Students who do not consent also cannot be used as a “control”, as being part of the control is being part of the study.</p> <p>In order to do research, you have to be certified by your IRB. Procedures may vary from institution to institution.</p> <p>You cannot start recruiting until you have obtained IRB approval for your project, so the paperwork has to be</p>
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<p>to submit to the human subjects protection unit on your campus. In order to determine a baseline measurement, it would be ideal to have as many students as possible take the FCI early in the semester. The two sections of introductory physics will also need to be compared to determine whether they are equivalent groups. This could also be accomplished using FCI scores. Your unit on Newtonian mechanics is placed about one third of the way through the semester, so students will also need to be recruited for interviews quite early in the semester. You decide to recruit students for the study during the first week of the semester.</p> <p>Since you will be recruiting participants from your own class, you are very aware that your responsibilities as an educator take precedence over those as a researcher, and you are also aware of the clear power differential between the students and yourself as their teacher. As a result, you decide to put your two graduate students who are not involved with teaching the class in charge of recruiting and consenting students for the study in order to avoid any possible conflict of interest or feeling of coercion to participate. In addition to recruitment for the study, you also need to consider that students might misrepresent their true thoughts in favor of what they perceive you as their teacher want them to say or volunteer simply to gain your favor. Therefore, your graduate students are willing to take on the data collection responsibilities as well, with support from your PER colleague at the other institution.</p>	<p>submitted well in advance.</p> <p>Conflict of interests must be avoided. Students may feel pressured to participate if their instructor asks them to. It has to be clear that participation is voluntary and will not reflect on their grade for the class.</p>
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<p>Scenario K-12</p> <p>You have been developing a new module for middle school students on Newton's Laws of Motion and how they apply to building and</p>	<p>Interpretation</p> <p>Working with teachers can be precarious. As adults, they can</p>
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<p>launching rockets. The development of the module is part of the education and public outreach plan for a grant you received from NASA, in which you have stated that you will test the efficacy of the new module compared to using traditional texts and labs. You were in contact with a local school district when you were writing the grant and they agreed to let you recruit teachers to test the module for the evaluation portion of your grant.</p> <p>During your literature review of the available work in science education, relating to both physics and other science disciplines, you found that there is promising work in utilizing problem-based learning modules for middle school students. You have decided to use this framework as the model for the module.</p> <p>You have now decided that you want to publish the results of the evaluation in a research journal to help inform the field about working with school districts, developing project-based learning modules, and moving the literature forward on young students' understandings of Newton's Laws of Motion. In order to meet the requirements of the granting agency and to better understand how the module will actually be used in the classroom, you will be investigating both evaluative and research questions in your study. Your evaluation question is: "What are the learning gains of students in classrooms utilizing the new module compared to those in classrooms using traditional texts and labs with regards to Newton's Laws of Motion?" To round out the study, you have added a research question: "What are the experiences of teachers adapting curricular materials to meet their needs in the classroom?"</p> <p>In order to answer your two questions, you decide to utilize a mixed-methods research design, combining quantitative data from a</p>	<p>provide consent. However they cannot speak for their students or school districts.</p> <p>A proper literature review is good science and it is ethical because we are not wasting the time of students with unwanted replication studies.</p> <p>Since a granting agency is involved, you will most likely need IRB approval.</p> <p>The evaluation question clearly requires student data. Underage students will necessitate extra levels of consent. Be sure to allow extra time for this.</p> <p>Using teachers as the subject in their classrooms can be tricky because you are potentially interfering with the students' learning, which will require special consent.</p>
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<p>Conceptual Newtonian Test from before and after the use of the module and in control classes that have agreed to participate in the study but not use the new modules. The qualitative data will come from observations of the enactment of the unit as well as open-ended interviews and teacher journals. You would like to video record the lessons for analysis later. In order to record the lessons, you will be recruiting graduate and undergraduate students who may or may not have conducted research in education in the past and may need to complete the necessary requirements to conduct human subjects research at your respective institutions.</p> <p>Even with parental consent, the videographers will want to select angles to minimize the capturing of the students faces. The teacher is the unit of analysis.</p>	<p>The decision to videorecord should not be made quickly. Do you need all the data video provides compared to what audio could provide? Sometimes the desire is to use the latest technology rather than what is best from an ethical or privacy decision.</p>
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8. Conclusion

Education is often unfairly criticized as being cyclic: one fad giving way to the next, nearly opposite fad. Scientific research can eliminate this pattern (politics aside) and allows for refinement of methodology and materials. Progress can be made, but it must be done so ethically. Education research must use human subjects and all human beings are afforded rights and protection under law. While education research is not as life-or-death as medical research, the impact of an unethical education study can be as long lasting as a medical malpractice. For example, it is well established that educational attainment is directly correlated to financial success.¹¹ Now imagine a study that leaves sub-standard teaching in place as a control group. It is possible that the students in the control will make less progress though the educational system. Real economic harm has been done to those people in the control group. Another example deals with psychological harm to subjects as a result of research. Some students put a lot of pressure upon themselves and even the most innocent-seeming interview might trigger a strong emotional response from the students. This is immediate harm to the person and researchers need to be prepared for this event.

As with all professions who use human subjects, there are systems in place to protect both the researcher and the participant. In the United States, IRBs exist to help navigate the legal and ethical pitfalls while steering researchers toward success. If there is one lesson to leave this article with, let it be this: IRBs are partners with researchers.

However, there is more to ethical research than protecting human participants.¹² Issues concerning authorship, proper methods, validity of questions, and many others remain as institutional traditions. As a maturing field, PER ought to establish its own code of ethics, both for the sake of maintaining the integrity of the field and, more importantly, for the just treatment of the participants in its research.

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- ⁷ A helpful resource concerning using human subjects is maintained at the US Department of Health and Human Services. They have decision charts to inform and assist researchers, <http://www.hhs.gov/ohrp/policy/checklists/decisioncharts.html>.

- ⁸ E. Brogt, E. Dokter, and J. Antonellis, "Regulations and Ethical Considerations for Astronomy Education Research," *Astr. Ed. Rev.* **6**, 43-49 (2007).
- ⁹ U.S. Department of Education, *Family Educational Rights and Privacy Act* (1974), <http://www.ed.gov/policy/gen/guid/fpco/ferpa/index.html>.
- ¹⁰ Additional examples, dealing with common PAER situations, can be found in E. Brogt, E. Dokter, J. Antonellis & S. Buxner, "Regulations and Ethical Considerations for Astronomy Education Research II: Resources and Worked Examples," *Astr. Ed. Rev.* **6**, 99-110 (2008).
- ¹¹ U.S. Census Bureau, "Table 217: Mean Earnings by Highest Degree Earned: 2003," *2006 Statistical Abstract of the United States*, <http://www.census.gov/prod/2005pubs/06statab/educ.pdf>.
- ¹² K. D. Pimple, "Six Domains of Research Ethics: A Heuristic Framework for the Responsible Conduct of Research," *Sci. and Eng. Ethics* **8**, 191-205 (2002).